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Record Water Wheels

NOT long since we were wont to look upon a 5000-hp. water wheel as a high-power unit. In fact even in 1902 such a unit was believed to impose fairly serious problems in design. To-day, however, we talk of 30,000-hp. and 50,000-hp. wheels with less awe than we did about 5000-hp. units then. It is pretty well known among hydraulic engineers that the manufacturers have designed and stand ready to back with guarantees wheels of the high powers mentioned. Such has been the progress since the early days of this century that these big wheels to-day impose no greater problems than did the 5000-hp. units then. The 30,000-hp. units, designed for a plant in Tennessee, may not become realities unless there is favorable hydroelectric legislation, but there is good reason to believe that the 50,000-hp. units, designed for use in the Niagara district, will materialize within a reasonable time. The electrical problems on these big Niagara wheels have not yet been worked out, but there is little doubt that the electrical engineers will be able to deal as satisfactorily with their end of the problem as the hydraulic engineers feel that they can with the hydraulic side.

Grouting

IN THIS issue begins the first of a series of articles on grouting by James F. Sanborn, division engineer of the Catskill aqueduct. The process has a wider field of usefulness than most engineers realize, and was developed after years of experiences on the Catskill work to a high state of efficiency. Many engineers not conversant with the results that have been achieved in grouting believe that the process is more or less uncertain and, in any event, applicable principally to compacting material behind a concrete lining. While this is the work for which it is generally employed, there are other fields for grouting which appear most promising. In the sinking of wet shafts grouting has already demonstrated its effectiveness and has been a means of saving a large amount in the cost and maintenance of pumping equipment. There are also attractive possibilities of grouting a tunnel heading which must pass through water-bearing ground. Tunnel foremen, however, are generally skeptical about delaying operations for this purpose, always hoping that the next shot will carry the heading beyond trouble. Their hopes, however, are not always realized, and often it would have been better to have suspended the work temporarily, grouted the seamy rock from drill holes in the heading and then proceeded without the trouble incident to a large flow of surplus water. Grouting also opens up opportunities in the solidification of rock at dam sites. The process is doomed to failure if entrusted to men who are not thoroughly familiar with its details, and for this reason Mr. Sanborn's practical suggestions as to how the best results may be achieved will prove particularly valuable.

Lesson in Demolition

DEMOLITION of a concrete structure, particularly if it be of the reinforced, thin-wall, circular-bin type, presents a problem which would vex a military crew. As there are no very heavy, vital sections, dynamite often cannot be placed at points that will bring the structure to earth in such a way that the fall will do further damage. The moving-picture enthusiasts and the two hundred spectators who went to see the South Chicago cement storage tanks dynamited, expected a tremendous crash and a breaking into fragments, as is the case when a chimney is thrown down. They were disappointed. Although all the columns were dynamited, the steel reinforcing rails, Atlas-like, bore their burdens valiantly. Only after the oxy-acetylene torch had cut every one of them away and the wooden shores replacing them had been fired, did anything like a crash occur. The tanks dropped over on one edge, a matter of 12 ft., but even then the thin shells of the tanks showed no signs of distress. Finally the slow process of pulling away a piece at a time from the top brought results. The experience with these bins should be of the greatest value in future operations of a similar kind. The problem was a relatively new one and recalls the early experiences in wrecking concrete buildings. The operation was slow and tedious. The oxy-acetylene torch has simplified the operation while air tools have helped to expedite the work.

New Defense Society Proposed

ENGINEERS who have attended the lecture course in military engineering, under army supervision, which has recently been concluded in New York City, and those who are enrolled in similar courses in other cities, will find William R. King's suggestion on page 507 of this issue constructive and timely. Mr. King proposes, in effect, the formation of a national defense association of engineers, his contention being that the interest in preparedness which has been aroused in technical circles should not be permitted to wane, but should be further stimulated in order that it may bear fruit in the form of further military training along intensive lines and in a utilization of the great political power of such a national organization as is suggested. The last point—the bringing of pressure to bear on our legislators at Washington—was strongly urged by Thomas H. Wiggin in his letter to the Engineering Record, published in the issue of March 18, page 397. There are many undesirable features of the Hay and Chamberlain army bills, now pending in Congress, and there has been a strong attempt, credited to a lobby of the National Guard, to defeat any proposal for a volunteer force such as was embraced in former Secretary Garrison's Continental Army plan. Mr. King, apparently, would combat such influences as this with his national association. Engineers, of course, do not wish to see the army program degenerate into a "pork barrel," but it is a question whether Mr. King's objects could not be secured by co-operation among the national engineering organizations rather than by the creation of a new national body for defense. There are already so many national security organizations that their efforts are being divided, rather than than concentrated. Then, too, the expense and administrative work required for such an organization as Mr. King suggests would be considerable, and there would appear to be no particular reason for it when the profession has at hand its own societies equipped to handle such work.

What is needed is not another defense society, but a unification of existing bodies into a single organization which could make its influence felt.

Garbage Disposal for New York

NEW YORK CITY is finally committed to a definite, though unsatisfactory, plan of garbage disposal. The Board of Estimate this week ratified the project for the installation of a plant on Staten Island, as noted in the news columns of this issue, and Commissioner John T. Fetherston has signed the contract for the new work. In the opinion of the officials of the Street Cleaning Department, the Staten Island installation is not the one best suited to the city's needs, but inasmuch as it was a case of half-a-loaf or none at all, the plan for the works has been put through. Commissioner Fetherston, in a report issued recently, recommended a location on Riker's Island in the East River, but such a storm of protest arose from property owners that this project had to be abandoned, although under this plan the city would have owned the land and taken over the works from the contractor at the end of a five-year period. In the case of the Staten Island installation the contractor furnishes the site and erects and operates the plant, paying to the city the sum of $900,000 during the five years the contract is in force. There is no definite arrangement for the city's acquisition of the works after this time, so that when the contract expires the situation will be about the same as it is now.

The acceptance of the Staten Island proposal postpones for years any feasible plan of eliminating the annual expense of the final disposal of all classes of waste (including ashes in addition to garbage), which, in 1914, resulted in an expenditure by the city of approximately $1,400,000. Through the complete utilization of all classes of refuse material it has been estimated that the city, directly or by contract for a period of 15 years, could install processes which would result in an annual profit, instead of a payment of $1,400,000 per year.

This unfortunate situation confronting the administration, Commissioner Fetherston points out, is beyond the control of the Department of Street Cleaning. Every effort has been made, through legislation and under existing laws, to reduce the cost of disposal, but Governor Whitman vetoed the final disposition bill in 1915 which would have allowed the city to build and operate its own plant. Inasmuch as the present contract with the company disposing of the city's waste at Barren Island expires this year, the only alternative is to accept the Staten Island plant. The city has had the benefit of expert advice regarding the course it should follow. Having disregarded it, the taxpayers must be prepared to pay the bill.

Justice to the Contractor

SINCE the publication in the Engineering Record of Nov. 6, 1915, of the editorial entitled "Making the Contractor the Scapegoat for Engineering Inefficiency," and the subsequent publication on Jan. 15, 1916, of Hillis F. Hackedorn's plea for equitable contracts, this journal has heard much comment favorable to the drafting by a competent committee of a standard form for the general clauses of engineering contracts. This journal has often expressed its criticism of the unfairness of engineering contracts which place absolute power in the hands of one who necessarily occupies a partisan position—the owner's engineer. That the power is abused cannot be denied. One has only to talk to contractors under conditions where they know that they can unburden their minds without danger to realize how true it is. Moreover, the one-sided form of contract cannot be defended by saying that the well-qualified engineer will not abuse the power given him. That may be true, but the fact is that these *ex parte* contract clauses are used by the fair and unfair engineer alike and in the latter's hands prove the undoing of the contractor and a disgrace to the profession. The small-minded, unfair engineer takes his cue as to the letter of the contract from the eminent engineer; he does not, however, copy and carry out the spirit with which the latter discharges his responsibility.

What is the remedy for this condition? In the judgment of the Engineering Record Mr. Hackedorn has suggested it—that representative bodies of engineers and contractors get together and draft a standard form of contract. The American Institute of Architects and the National Association of Builders' Exchanges have done notable and very satisfactory work in this connection. What they have done for the building field other organizations should do for general contracting.

The American Society of Civil Engineers is by all odds the body best qualified to do this work. Within its membership are any number of engineers and contractors competent to draft these clauses. Contractors and engineers should be equally represented on the committee. In order, however, to inspire the greatest confidence on the part of contractors it would be well to invite representative contractors, not members of the society, to co-operate with the committee.

There is a great work ahead for such a committee.

High Prices, Labor Shortage and Prospective Work

WITH market conditions and general business good, it has now become a question whether high prices of materials—principally structural—and a shortage of labor will curtail the large volume of construction work that would normally be carried out under such conditions. From present indications it appears that high prices of materials will be responsible for no more than a partial diminution of construction activity. It is thought that the top has been reached in steel. While conditions do not point to a break and a sudden drop in prices, it seems that the mills will have a chance to catch up and that the insistent demand for steel at any price is over. Certain it is that enough has already been bought to account for a good volume of construction. While it may be that prices will not decline far enough to tempt the railroads to extensive construction, there is an insistent foreign and domestic demand for many manufactured articles that continues to warrant industrial expansion. There is plenty of capital to finance this expansion. It is possible that when the markets of the world are again opened to American investors by the close of the war, with prospects of larger returns than can be had at home, and this industrial expansion is brought to an end, the first fall of prices will bring out railroad and public work which cannot be carried on at present.

Labor flows to the activities that can afford to pay it most. At present urgent needs of the warring nations make it profitable for them to pay certain industries here so well that those industries can supply themselves with labor at the expense of every other activity. For the railroads and public-improvement projects to attempt to meet these prices would make improvements cost more than such utilities could afford to carry later. How seriously this will curtail the total volume of contract work is as yet an unanswered question. If too great a volume of such work is attempted, contractors will have to bid against each other for what labor is left after the war industries have supplied their needs. For this reason, large firms are already hesitating to take on much new work. Immigration has been practically shut off since the war broke out, and with the way clear in other respects for considerable permanent expansion, this country finds itself with the same or a less number of workmen than it had two years ago, and with no outside supply to draw on.

It is likely, therefore, that while the price of materials will neither rise nor fall greatly, the price of labor will go up; that the volume of construction will not be unusually large as compared with normal times; and that the only phenomenal expansion will take place in private industries which peculiar conditions have made very profitable.

To Classify Technical Literature

AT the recent meeting of the joint committee on classification of technical literature, composed of representatives of American technical societies, a tentative classification was proposed, and it was decided to assign to each society the subject or subjects which it could best cover. This work is of great importance. A logical classification of all technical literature will be found not only of immediate practical value, but invaluable in the future as an aid to further scientific investigation and research. To be able quickly to locate all the available literature on a given subject is one of the first requirements for that thoroughness which results in progress and new knowledge.

It must not be assumed that college professors or recent graduates only are to be benefited by such classification. One of the most impressive facts emphasized at the meeting was the interest which large manufacturing and commercial companies have in this subject. Many already have extensive classifications of the literature in their own fields, and employ trained librarians to care for and add to their accumulation of books, pamphlets, reports and data.

The Engineering Record questions the wisdom of two of the assignments—roads, streets and highways to the American Highway Association, and hydraulics and sanitation to the American Waterworks Association. While to the uninitiated these seem logical assignments, those familiar with the two associations know that they do not rank with the other technical societies to which sections of the classification have been referred. However excellent the work of the American Highway Association in its sphere, it does not pretend to be a technical body. The American Waterworks Association has done some good technical work, but it is not organized on lines which would insure the greatest co-operation with the work of the committee. These two groups of subjects should have been assigned to the American Society of Civil Engineers, and it is regrettable that that body was not represented to assist with its counsel in the distribution of subjects.

Now that the success of the whole movement is in the hands of the various technical societies, this journal strongly urges prompt action on the part of each body. A most careful selection of the best man or men in each particular subject must be made, preferably those having a deep interest in indexing and classification. The principles upon which the whole scheme is based should be clearly presented to them. Success then depends upon the vigor and interest which these men manifest in prosecuting the work, and there should be an immediate request for resignation if professional or other work so prevents their participation as to delay the work unduly. In a work of such importance there should be no difficulty in getting the right men—in fact, they should be eager to contribute their services.

Medieval Revival in Warfare

THERE is a touch of gruesome humor in the doings in the trenches. As one looks over the results of modern scientific effort and resourcefulness he is inclined to quote that old saw, "There is nothing new under the sun." Could the hosts who fought in Flanders several centuries since look down upon the scene of their battles, they would, while noting vast improvements, miss little of their old equipment save the bow. Indeed, it is rather a wonder that, in the renaissance of ancient methods, the bow has not yet appeared on the firing line. To be sure, we have the aeroplane dart, intended for the same amiable purpose, but even the bow itself might prove a weapon not to be despised in repelling a night attack where general direction is about the only thing to be hoped for in the way of aim. It is extremely interesting to note the way in which modern technical ingenuity has taken up and improved the exact line of offense and defense which has marked close range warfare almost from the earliest use of firearms.

On the defensive side the steel headpiece has reappeared in the trenches after more than 200 years of disuse. It is rather better made, considering what is required of it, than the old pattern, and saves many a head from being broken by shrapnel bullets, which it easily turns. In fact, it is reported successfully to deflect bullets traveling 2500 ft. per second or more. Ordinarily speaking, such a projectile would penetrate at short range a half-inch of boiler iron very easily if it struck squarely point on, but the modern bullet, having a long and tapering point to decrease the air resistance, is fairly easily turned aside, if it strike at an angle, as is likely to be the case, a well-shaped headpiece. Except for this great penetrating power we should doubtless have body armor as well; in fact, it is being tried in Italy. Its place is partially taken by small loopholed steel shields behind which a rifleman can work his way forward with a fair degree of immunity from hits.

Another very useful item in defense is the trench periscope, of which divers patterns may be found advertised in the foreign papers. It is a simple combination of mirrors very useful for looking over a parapet, either directly or with a pair of binoculars, the mirrors being made large enough to permit the latter use. Old Hevelius, who flourished about 1650, might well smile to see his polemoscope put to such good use. This instrument, on which he set great value, was quite exactly the same thing, except that it was combined with a single-barreled opera glass. Its modern form is merely better made and gives a bigger field.

The barbed wire entanglement is substantially the old abatis improved in structure. A tangle of barbed wire is certainly better than a small tree with its limbs carefully sharpened and turned point forward to the enemy, particularly if the wire is thoughtfully painted green, as in some large shipments recently, so as to make it less conspicuous. In the same connection one must not forget the pits with sharp stakes driven at the bottom, and the amiable caltrops, those four-pointed iron affairs which, thrown on the ground, always stand with one point up. The old ones, to be sure, were of roughly forged iron, while technical skill has now benevolently provided caltrops of stamped steel with visiously sharp edges and points adapted to the same old work. The water-filled moat is no part of field fortifications now, but its place is well supplied by the desperate defense organized along canals and the old tactics of flooding the country to drown the foe.

When it comes to means of offense, modern ingenuity has made admirable use of medieval precedents to an extent that is really astonishing. First to the front comes clattering down through the centuries the Roman catapult, the spring engine invaluable for heaving stones in attack or defense. It was used all through the Middle Ages until temporarily driven out by cannon and has once more appeared here and there in the trenches, just as serviceable as when Caesar's legions used it with less dangerous projectiles. Indeed, it and similar weapons are singularly convenient when the ranges draw within that which can be conveniently managed by an ordinary mortar. The German fire-throwing machine, too, comes of an ancient and honorable lineage, going back to the days when the besieged doused the enemy with boiling oil and burning pitch. It is a very simple device, this flame projector—merely a tank filled with petrol under a pressure of several hundred pounds per square inch, and provided with a suitable long nozzle from which the liquid, inflamed as it leaves the tube by an electric spark, can be directed in a neat stream into the enemy's trenches over a distance of a hundred feet or so. Had petrol been available 500 years ago it would have been welcomed for similar use on many a castle rampart. Even the bomb spreading poisonous gases cannot lay claim to high novelty, since it is a direct descendant of the Chinese stinkpot, which goes back to unknown centuries. The wholesale use of deadly gases poured from the trenches and borne by the wind against the enemy seems, however, to be an innovation—a refinement, perhaps, of the old scheme of smoking the enemy out, tried in many a medieval siege.

Studying missile weapons a little further one finds reversion to deadly schemes foreshadowed, at least, in the wars of the Middle Ages. The hand grenade, for generations a favorite weapon at short range, has once more come into its own. To be sure the modern grenade case, charged with high explosive, is vastly more effective than the crude bomb hurled by many a stalwart grenadier two centuries or so ago. Now, as then, it takes various forms, sometimes thrown directly, sometimes lashed to the end of a stick to give a better swing, and yet again delivered by some rude kind of sling which brings up vague recollections of the fate of Goliath.

Modern ingenuity has presented one interesting novelty in the grenade mounted on the end of a rod, which can be shot from an ordinary rifle. The propulsion of a shell bigger than the bore of the weapon from which it is fired must be given a prominent position among modern innovations in trench warfare. It has, indeed, quite displaced the trench mortar of earlier times, the piece light enough to be carried by a couple of men and yet efficient in lobbing small bombs into the trenches with a tiny charge of powder to drive them. A 10-in. projectile launched by a 3-in. mortar, however, must be credited to modern engineering skill.

It is only fair to note that the advent of these cheerful innovations has been met by improved trenches, deeper and narrower than of yore, and when feasible partly roofed over so that popping a bomb into them is much like trying to snap a nickel into a slot machine. Similarly the modern trench is more liberally provided with traverses, or their equivalent, than were those in which Uncle Toby valorously served, so that even when a shell drops into the slot it very likely will disable no more than two or three men.

The mitrailleuse, again, however clever its mechanical design, finds ancient prototypes in the armories of Europe, and oddly enough even the sliding block of the Krupp breech action may be found in a piece of the sixteenth century in the Berlin Arsenal. The old-time arms maker was far less deficient in inventive ingenuity than in means of execution.

Mine, counter mine, and petard, all have their modern equivalents, reinforced by gun-cotton and trinitrotoluol, but used with no more desperate courage now than in the Thirty Years War. Even the familiar scheme of screening guns and men by carefully placed foliage harks back to the time when Birnam Wood came to Dunsinane. In adroit concealment, however, the war widely utilized an improvement which is strictly of modern origin; the painting of ships, guns, and even men, in streaks and spots of varied colors so that they are quite lost in the shifting light over either sea or land. This has its origin, doubtless, in recent investigations of protective coloration in certain animals, which nature has provided with spots and streaks that blend so perfectly with the creature's wonted surroundings as to render it almost invisible at a short distance. Here increasing knowledge of the conditions of visibility has enriched the art of war with a radically new device.

All in all, it is rather remarkable to discover how the close-range trench warfare of the present has brought back means of destruction altogether similar to those of the ferocious hand-to-hand struggles of the Middle Ages.

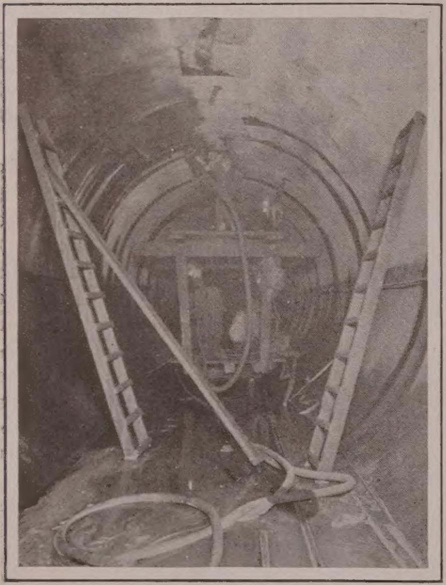
Grouting an Effective Remedy for Stopping Leakage in Tunnels and Shafts

First Article in Series Summarizing Experience on Catskill Aqueduct—Successful Work Depends Upon Attention to Details

By JAMES F. SANBORN
Division Engineer, Board of Water Supply, New York City

Into "bad ground" tunnel contractors have sunk thousands of dollars of prospective profits. A knowledge of up-to-date grouting methods for cutting off leakage, however, might have shifted much of this loss over to the profit side of the ledger. In this series of articles Mr. Sanborn crystallizes the experience of many years in the grouting of the Catskill aqueduct tunnels. The process, properly applied, has a wide range of usefulness—in consolidating material behind concrete linings, in cutting of large flows of water in tunnel headings and shafts, and in consolidating material at dam sites. To achieve success in this work a thorough understanding of the problem is essential and strict attention must be given to such details as the drilling and placing of grout holes, consistency of mixture, injection pressure, selection of equipment, control of flow, character of rock seams, etc. On such points as these the reader will find in this series of articles a fund of valuable information.—Editor.]

ON the extensive tunnel work of the Catskill aqueduct grouting was used as one of the major operations in securing a water-tight structure, particularly in the case of the pressure tunnels, which operate under heads of several hundred feet. In the case of the Hudson River siphon the depth of the tunnel below hydraulic grade is 1500 ft. where the aqueduct crosses the river at Storm King. In spite of these unusual heads, operating tests of the aqueduct prove it to be remarkably tight, showing the efficiency of the grouting of rock seams and openings in connection with the sound concrete lining.


CAR WITH UPPER PLATFORM FOR REACHING GROUT HOLE CONNECTIONS IN ROOF

One often hears the remark that grouting, in itself, is very uncertain in its results, and for that reason cannot be relied upon in construction work. It is, indeed, regarded as a last resort in some cases for repairing defective work and frequently, no doubt, has failed of success. This belief seems to be due to the fact that in cases where failures result the work is done in the dark, so to speak, for the reason that the grout is forced through pipes or holes cut into masonry or invisible seams of the rock. To secure good results in grouting the greatest pains must be taken in conducting the process, with every attention to the details and a thorough understanding of the nature of the problem.

CATSKILL GROUTING SUCCESSFUL

MOTOR-DRIVEN COMPRESSOR USED IN TUNNEL FOR LOW AND HIGH PRESSURE WORK

It is noticeable that in the pressure tunnels of the Catskill aqueduct the grouting was most successful in fulfilling its purpose in those cases where it was used outside of a particularly well made and impervious concrete lining, thoroughly protected from water under pressure while the concrete was setting. Here the conditions were favorable for the successful application of the process and the work was well done with adequate equipment.

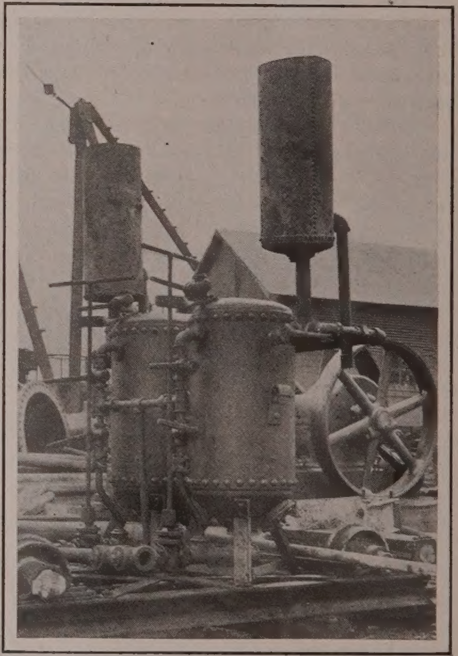
The grouting process also was used with considerable success to cut off heavy flows of water from many seams in shaft sinking and tunnel driving, with conditions very unfavorable for a complete circulation of grout, and while of great advantage to the work in such cases the success was not always so marked in completely cutting off the leakage as was the grouting back of the concrete lining. Grouting was also used with marked success at several of the dam sites for filling seams in the rock beneath the dam foundations.

In view of the importance of securing a thorough job of grouting in cases where, in the permanent work, provision was made in this way for eliminating the leakage from dams or tunnels under pressure, careful consideration of the geology of the rock and the distribution and nature of the openings was made, and the method of grouting carefully adjusted to meet this condition. For example, in the case of porous water-bearing sandstones, the irregular character of the openings was entirely different from the fault planes marked by heavy movement and crushing of the rock frequently encountered in ancient gneiss and granite along certain parts of the line. Similarly the clean-cut, well-defined joints in the horizontally bedded bluestone of the Catskill region, where little faulting has taken place, must be treated in a different manner from the ancient and highly disturbed shales of the Wallkill Valley section. Very thorough studies were made in the beginning of the work to secure data on all available experience in grouting wet ground under high pressures, as it was realized that the success of the pressure tunnels depended largely on the possibility of waterproofing them against outward leakage.

Considerations of the best method of drilling and placing holes for grouting, the proper consistency of the grout mixture, the best cement to use, what injection pressure should be applied and the best means of producing and controlling the flow of grout were among the matters most vital to the success of the process.

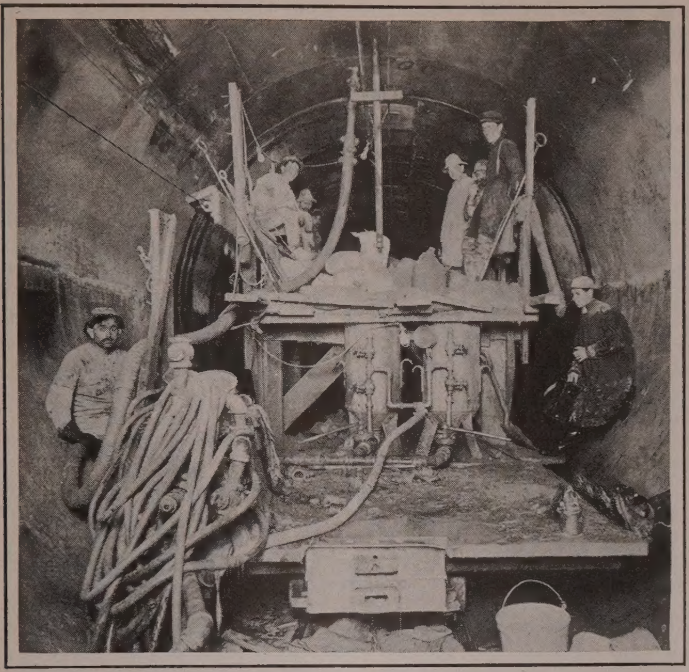
GROUTING EQUIPMENT

As the purpose of grouting is to force a mixture of sand, cement and water into the spaces to be filled, the best equipment to use in any case depends very much upon the pressure necessary to make the grout travel, and the consistency of the mix best adapted to the kind of openings to be filled. If a considerable yardage of grout is required, an equipment with large capacity is desirable, while a smaller quantity placed slowly under high pressure may demand a different equipment to secure the best results.

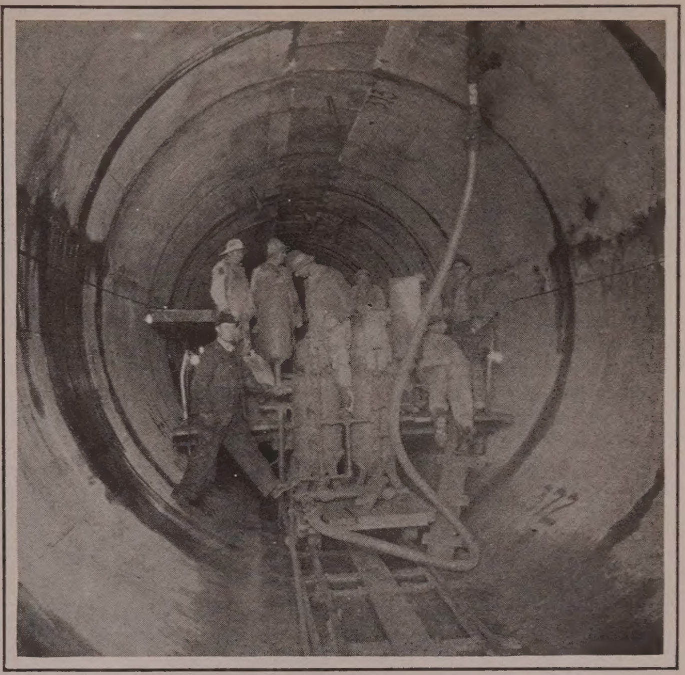

TWO AIR-MIXING, AIR-EJECTING GROUT TANKS OF TYPE USED ON CATSKILL WORK

Grouting is often done by pouring through pipes arranged in such a way as to secure the necessary pressure. Commonly, however, more pressure than that afforded by the head of grout alone is required. The equipment ordinarily used may be classed as follows:

1. Reciprocating pumps furnishing a continuous flow with independent means of mixing the grout.



LOW PRESSURE GROUTING CAR WITH UPPER CHARGING PLATFORM AND DUPLICATE TANKS RECEIVING AIR FROM SHAFT TOP



ANOTHER TYPE OF RIG ON PLATFORM CAR—NOTE THE MEASURING TANKS EMPLOYED FOR THE MIXING WATER

2. Grouting tanks, which are of two classes—(a) paddle mixing and air ejecting and (b) air mixing and air ejecting. The Canniff tank of the latter type was used very largely on the work of the Board of Water Supply, particularly in grouting the shafts and pressure tunnels.

Douglas hand pumps were used in the low pressure grouting of the dry packing of the new Croton aqueduct, where the grout was mixed by hand in a tub. Similar pumps were used for the high pressure grouting of the Torresdale tunnel, operated by five men. Small Cameron pumps, air driven, were used in grouting the Battery tunnel of the New York Subway, and such pumps are commonly employed for grouting when the quantities to be placed are small. At a French mine shaft, sunk by grouting, the valves consisted of steel balls, weighing 10 lb. each, which struck so hard in closing as to prevent the accumulation of grout on the valve seats. In several shield-driven tunnels the grout pump consisted of a large cylinder into one end of which the mixed grout was drawn, and forced out under pressure by a piston or plunger driven by compressed air. Studies for such a device were made by the designing department of the New York Board of Water Supply, but it was never used on the work. The wear in the cylinder and stuffing boxes of such a machine is very great.

The paddle mixing and air ejecting type of grout tank has been extensively used on shield-driven tunnels and elsewhere. They have many advantages, and are economical when large quantities of grout are to be placed, as in grouting dry packing. The moving parts and stuffing boxes wear rapidly, while the paddles and shaft become coated with grout. As the machines receive very little care in a tunnel, they wear out fast.

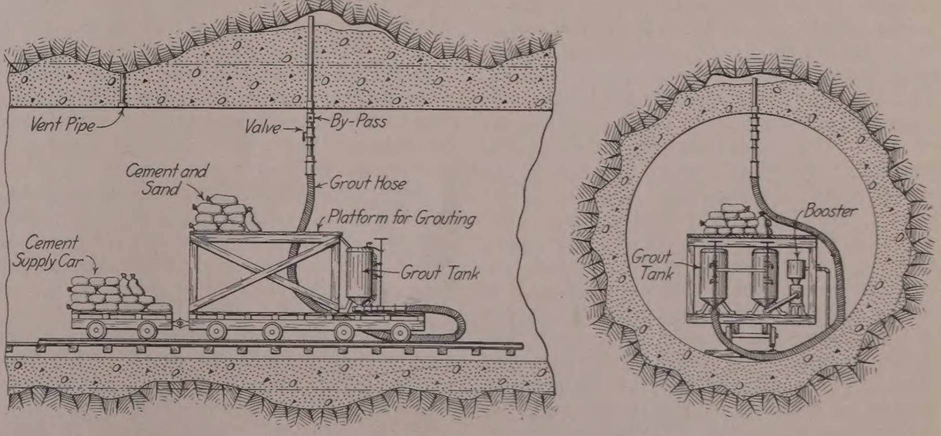
In grouting the shafts and pressure tunnels of the Catskill aqueduct the equipment consisted of tanks of the Canniff type, in which the grout was mixed, a batch at a time, and ejected by compressed air power through a heavy wire-wound high pressure hose, attached by fittings to pipes previously secured in position at the point where the grout was to be introduced; 2-in. or smaller grout pipes and 2½ or 3-in. hose was commonly used.

COMPRESSED AIR REQUIREMENTS

The compressed air was made on most of the contracts by air compressors of large capacity, which were part of the plant used while driving the tunnel and furnished air at pressures from 80 to 100 lb. per square inch. Two of the contractors of the city aqueduct department installed small electric motor-driven compressors in the tunnel for supplying air for the grouting equipment. In one case the compressor was on the same car with the tanks and in the other on separate trucks moved along with the grouting plant by means of the electric motors used in hauling material. This was an Ingersoll compressor with a capacity of 129 cu. ft. of free air per minute and was employed to furnish air at 300 lb. pressure for the high pressure grouting, thus getting rid of the slow and wasteful Westinghouse boosters which the same contractor had used on a previous job. It was found that compressors with a capacity smaller than 100 cu. ft. of free air per minute, which were tried on one of the contracts, were unable to supply enough high pressure air at 300 lb. per square inch for the grouting operation.

The chief advantage of the Canniff grout tank is that it has no moving parts to be cut out by grit, leak air, and delay the work for repairs, as happens in the case of pumps. This advantage is greatly in favor of the grout tank, particularly for tunnel work, where the darkness and distance from the shop and supply room make renewals slow and expensive. The time lost in making renewals with this tank is very little, as only the gasket of the door and the valves are liable to wear. Its compactness and light weight are great advantages, as the floor space occupied by a tank is very small, not over 4 sq. ft. The Canniff tank is well adapted for handling grout rapidly. As high as 1500 batches or 115 cu. yd. of grout have been placed in one day of three shifts by a pair of tanks. A small force operates the tanks and no high-priced men are required for repairs or operation. Either rich or weak grout can be used, and the tank is adapted for low as well as for very high pressure.

A disadvantage of the Canniff tank is shown when used for high pressure work, when the grout is discharged very slowly into fine seams, taking a long time. In such cases the cement has time to settle out of the mixture and clog the openings. However, as very thin grout should be used in such cases, the difficulty is not very serious practically.



GENERAL LAYOUT OF MOVABLE GROUTING PLANT IN TUNNEL

Unless great care is taken with any type of grout tank to shut off the discharge valve, the instant the last of the grout leaves the tank, an after-blast of air follows, which has a bad effect in stirring up the grout. The air tends to collect in the space to be grouted and is displaced with difficulty by the cement. The men operating the tanks, however, become very expert in controlling the discharge. Both the air-mixing tank and the paddle-mixing tank discharging a single mixed batch by compressed air pressure, are well adapted to mixing and discharging a large quantity in a short time, especially into a large open space which takes grout easily. In work requiring high pressure, using thin neat grout, the results with the Canniff tank are also very good. The grout commonly used was 1:1, but grout of a consistency of 1 cement to 2 sand was often mixed and discharged without trouble.

The air mixing and air discharging type of machine is, theoretically, the most unsatisfactory of all, and in the first specifications for the Catskill aqueduct it was not regarded with favor, but has been extensively used, and has come to be regarded as the most economical device for grouting in the tunnels. The air mixing feature of the Canniff tank is only partly successful, as it is necessary to use a paddle for stirring up the sand and cement. When charging the tank the water is first added, then a bag each of sand and cement, and with the mixing valve in the bottom open slightly air bubbles up through the charge, which is further mixed by hand with a few turns of an iron paddle. The door is then closed hard, air turned on the tank, the mixing valve closed, and the discharge valve opened.

In some cases, to do away with the after-blast of air as the batch started to leave the tank, the air supply valve was closed, and the air in the tank expanded, forcing the grout through the hose. This method was not commonly used.

To avoid the bad effect of allowing the air to blow through the hose, which results in waste of power as well as injury to the grout already placed, the air valve is closely watched to note the fall of pressure attendant upon the discharge of the grout, and a further warning is given through the "kick" of the hose as the grout is discharged through it.

PLANT FOR LOW PRESSURE WORK

The low pressure grouting car and equipment used in several of the tunnels are shown in the photographs. For the low pressure work two grout tanks were mounted on a car provided with a platform for handling the cement and sand, which was emptied directly from the bags into the grout machine (a bag of sand and a bag of cement to each batch), although two bags of sand were sometimes used to each bag of cement in grouting dry packing. The water was commonly added by hand by means of a bucket from barrels on the car or from the tunnel invert, although one contractor provided water tanks with an overflow at a designated height. These water tanks, of light gage steel, were mounted on the grout tank and were emptied by a three-way valve. A belted centrifugal pump kept a continuous stream of water circulating to supply the tanks, but did not prove as reliable as a small air-driven reciprocating pump, which was used later. The sand and cement were transported on flat cars by the tunnel mules or trolley motors to the grouting equipment and handled by hand. It is essential for the rapidity of low pressure grouting work that plenty of material be always stacked up on the grouting platform, as the operation is so rapid that the stock is quickly exhausted unless constantly renewed.

PLANT FOR HIGH PRESSURE WORK

For the low pressure grouting, the air supplied by the compressors on the surface was found adequate, but for high pressure grouting air at 300 lb. pressure per square inch was used on account of the high ground-water pressures, often over 100 lb. per square inch.

The high pressure grouting equipment consisted of a car, smaller than that used in the low pressure grouting and carrying one or two grouting tanks. The amount of grout used in the high pressure operation is only about one-tenth of that placed in the low pressure operation and, furthermore, it takes much longer to discharge each batch.

In addition to the grout tank, the high pressure grouting car carried a Westinghouse air pump or booster operated by compressed air from the tunnel plant at 100 lb. pressure, delivering air at 300 lb. pressure to the grouting tank. Another grouting tank was commonly mounted on the car, but was used only as a receiver for the high pressure air. As in the low pressure operation, the grout was discharged through a wire-wound hose from the tank to the grout pipe set in the concrete or rock. Each pipe to be grouted was provided with a nipple and special plug cock to which the hose was attached by a union.

QUANTITY OF GROUT PLACED IN 12-FT. AQUEDUCT TUNNEL—TYPICAL STRETCH

	Length of tunnel grouted	No. of connections made	Shifts worked	Cu. yd. liquid grout
Low pressure grouting*	10,113 ft.	170	69	1,744
High pressure grouting†	10,113 ft.	1,670	113	150

*Most of the grout placed in the low pressure operation filled the space above the concrete in the tunnel roof.

†Most of the high pressure grouting was to cut off leaks from seams in the rock, and to fill pans.

At the Hudson River siphon it was necessary to use 700 lb. per square inch in grouting. As it would be exceedingly expensive to provide air at this pressure, an air-driven Cameron pump fitted with a small plunger on the water-end was employed, and water at 700 lb. pressure was pumped into the Canniff tank in which the grout was mixed. This device proved successful in grouting against a ground-water pressure of 475 lb. per square inch in the Hudson River siphon, 1100 ft. below water level. About 3000 ft. of tunnel was grouted by this device, and a similar equipment was used in grouting the famous wet seam met in the Hudson siphon near the east shaft while driving the tunnel. The water pumped in at the top of the tank to displace the grout mingled with the charge and diluted it considerably.

Very little trouble was experienced due to blowing off of fittings, although rather serious accidents have resulted from this cause. One of the men had his jaw broken by a grout hose early in the work, which no doubt had a good effect in making everybody look well to the safety of the gang. One of the foremen was struck in the face by the grout when blowing out a clogged hose, and lost the sight of one eye. The men charging the tanks suffered greatly from cement burns, because of the generally wet condition around the grouting machine.

GROUTING OF SHAFTS

Grouting was employed during shaft sinking to cut off flows of water which would interfere with the progress of the work, and during tunnel driving for the same purpose. Most of the grouting was done, however, after the completion of the tunnel and the placing of the concrete lining. It was used, first, to complete the filling of the considerable space over the concrete arch beneath the rock roof, which could not be completely concreted, as well as the spaces in dry packing of rock outside of steel roof support, which was extensively used. Secondly, in cases where water was encountered flowing into the tunnel through seams, provision was made by appropriate systems of piping to impregnate the seams with cement for the purpose of cutting off the inward flow of water, and at the same time prevent the escape of water from the tunnel after it is in service.

Of all the operations connected with the tunnel work, shaft sinking is perhaps the slowest, most hazardous and expensive per cubic yard of material handled, especially when much water is encountered, as water falling to the bottom of the shaft and collecting to a considerable depth makes the mucking of the broken rock extremely difficult. After drilling and shooting, much time is lost in getting the pumps under way again and the water rapidly collects and floods the bottom.

It is evident, therefore, that to keep the water out of the shaft, as it is sunk, grouting of water-bearing fissures in advance of excavation must be of great advantage. This process is best accomplished by drilling holes in the bottom of the shaft in lengths not exceeding about 20 ft., and generally from 5 to 10 ft., placed around the outside of the area to be excavated. As a precaution against flooding the shaft, when a heavy flow is expected, pipes fitted with valves are set in the drill holes when they are started, and the drilling is continued through the valve, which can be quickly closed when the water is struck. When all is ready, the grout is poured or pumped into the rock seams through pipes attached to the fittings connected with the drilled hole.

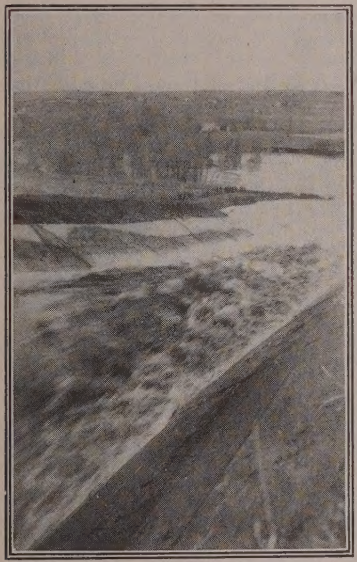
As in all grouting, for filling large cavities thick grout is placed, while for success in filling very fine seams, exceedingly attenuated mixtures are employed—5 lb. of cement and 25 gal. of water in the early stages of injecting the grout—with the idea that the water will carry the cement as far as possible into the fine seams and avoid blocking up close to the drill hole. This is a very important point if complete success in the process of shaft sinking is to be attained.

After the water is cut off, sinking is resumed with light shots to avoid re-opening fissures in the rock closed by the grout. A number of shafts in other work have been sunk by this method through extremely wet ground which would have been impossible, or at any rate far more expensive to sink if pumping alone had been depended upon. Flows as high as 3000 gal. per minute have been cut off by this method.

On the Catskill aqueduct about fifty shafts, from 80 to 1100 ft. deep, were sunk for the tunnels. As a rule, no very great difficulties were met, as the rocks in this region are old, well compacted and strong, and, except in a few places, have not suffered disintegration to such a degree as to make shaft sinking particularly difficult because of the presence of great quantities of water. In few shafts was the maximum leakage over 200 gal. per minute, but in several cases it was so great that grouting was used during sinking to cut off or reduce the flow of water. For example, shaft 4 at High Falls (later described), which was very wet, was flooded out six times. In one period of the sinking no less than ten pumps were placed in the shaft and with air and discharge lines made it literally impossible to carry on the shaft sinking operations. Grouting, however, was done with success.

Eliminate Costly Pumping

When the quantity of water exceeds 15 or 20 gal. per minute in a shaft, it is generally necessary to install pumps, and when the quantity exceeds 200 or 300 gal. per minute, the pumping item becomes very costly because of the power required and the added trouble and delay of installing power lines for air and for pump discharge. The mucking is much delayed, as the men are unable to see the bottom and they naturally work more slowly in the water. Shaft 4 at High Falls on the Catskill aqueduct is an example of a timber-lined shaft which was grouted ahead of the excavation. All the water was not sealed off and pumping had to be employed to keep the bottom clear so sinking could proceed. Shafts 4, 20, 21, 22 and 24 in New York City, in which grouting was done, were all lined and concreted and the leakage almost completely excluded as the shafts were sunk. Had they been timbered shafts the quantity of water entering would have been very great. In all these shafts many water-bearing seams were met as the holes were drilled in the bottom. Pipes were swedged into the holes and grout forced in by air pressure from a tank machine. The completeness of the grouting was tested by drilling more holes, which were grouted in turn, and the same holes were frequently grouted several times as the upward rush of water under pressure often seemed to wash out the grout before it had time to set.


FLUME WAS FULL AT TIME OF BREAK

[*In the next installment of this series of articles Mr. Sanborn will describe shaft-sinking difficulties and how they were overcome by grouting.*—Editor.]

Sioux Falls Flume Failure Threatens Water Supply

Water Rushing Down 14 per Cent Grade Undercuts Toe Wall at End of Spillway, Destroying Flume for 600 Feet

FAILURE of the flared spillway and several hundred feet of steep lined flume at the end of a drainage ditch carrying surplus waters of the Big Sioux River by the city of Sioux Falls, S. D., March 12, made the waterworks officials apprehensive for a time that the cutting would recede through a ridge and drain the gravel beds from which the water supply is obtained. The ditch is about 16 miles long and makes possible the cultivation of a large area of bottom lands in the valley of this extremely sinuous river channel. The greater portion of Sioux Falls is located in a loop of the river. The ditch discharges below the city and the falls, cutting across the neck of the loop, with an abrupt fall at the end, of 100 ft. in the last 1000 ft. When the officials became apprehensive of losing their water supply they started to shut off the water at the upper end of the flume, but the farmers whose property would have been flooded obtained a restraining order. Fortunately the cutting slowed down materially after receding about 600 ft., as it encountered stiff clay, and at last reports the water is still tearing down the 14 per cent portion of the grade and dropping more than 60 ft. into the enlarged channel cut back from the river.

WATER DROPS 60 FEET FROM END OF BROKEN FLUME NEARLY TO RIVER LEVEL

Through the ridge at the upper end the flume is 24 ft. wide on the bottom. The steep part is 8 ft. wide on the bottom, 7 ft. deep and has 1½ to 1 slopes. The concrete is 8 in. thick on the bottom and 6 in. thick on the slopes, and was reinforced with ½-in. rods 3 ft. one way and 2 ft. 9 in. the other way. The toe wall at the end of the flume was extended only 6 ft. into the soil, whereas rock is said to be about 14 ft. farther down.

The slope of the flume was flattened toward the discharge end from the steepest portion, 400 ft. of 14 per cent grade, to 300 ft. of 11 per cent, 50 ft. of 6 per cent and 65 ft. of 3 per cent.

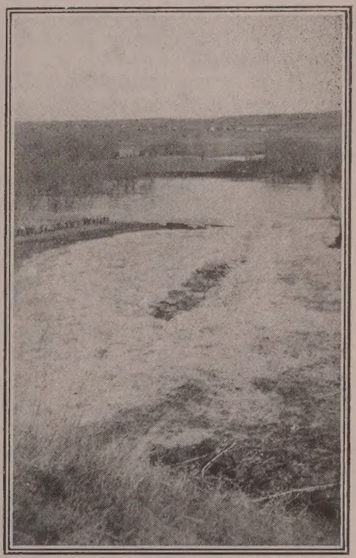
Observations made ten days after the break showed the water discharging through an overhanging portion of the flume 12 ft. long, but there was a considerable volume discharging over the clay underneath the flume. It is reported that the water has heretofore worn holes through the flume that had been repaired from time to time. With the large joints there is plenty of chance for water to get beneath the slabs. Until the flood season has passed no attempts can be made to repair the flume.

Defense Association of Engineers Is Proposed

Plan to Capitalize Interest at Military Lectures in Permanent National Organization

By WILLIAM R. KING, M.E.
New York City

Monday night, March 27, marked the termination in New York City of that most eminently successful course of lectures on the subject of military engineering, which, organized under the auspices of a representative committee selected from the various national societies, has served for the past two months to focus the attention of the engineering profession on the essential part which must inevitably fall to their lot in any adequate and comprehensive movement taken for our national defense. The success of this series of lectures has been demonstrated, not only by reason of the general, concrete and interesting view of the subject which has been so liberally provided, but pre-eminently by the enthusiasm, unity of purpose and overwhelming interest which has been aroused among the members of the engineering profession, irrespective of age or professional affiliations.


BROKEN SLABS INDICATE FLUME LINE

Nightly, as the course progressed, this audience of conservative and thoughtful men gained in fixity of resolve and intensity of interest, only to realize, with universal and heartfelt regret, that the course is run and no goal reached; that the potential energy of concerted action by some 3000 participants must be dissipated without further finite results.

It is true that, inductively, some fragment of this energy has been transferred to that more active field which the justly popular training camp movement is intended to supply, but to the rank and file, those who have been so unfailing in attendance at these meetings, and especially to men of more mature years, no further field for united effort is open for exploitation. Marooned, with appetites abnormally developed, yet deprived of further food for thought!

But why should the momentum thus far acquired be permitted to dissipate without useful effect? The energy evolved by such a movement conserved, controlled and directed in proper channels, is capable of exerting great influence, not only educational, but psychological and political as well. To perpetuate, to utilize, to stimulate such potential force, is it not desirable that this "good will," and "going value" should be incorporated in a permanent organization?

NATIONAL ASSOCIATION OF ENGINEERS FOR DEFENSE

To the members of the present temporary committee the rolls of participants in the lecture course are available. The means being at hand, the curve of enthusiasm at its peak, the present is the time to act. It is not the intent that the suggested association should in any way supplant, compete with or encroach upon the sphere of usefulness now so ably filled by existent national associations, but, rather that it shall supplement and extend their work by specialization and adaptation to military needs, and at the same time form a rallying point for those of our profession who would prepare themselves, in times of peace, better to meet their obligations when called for our national defense.

In the development of the proposed organization all efforts should be directed along practical, rather than conventional and academic, lines. The essence of success must lie in active participation by each individual member in the work of the society, and not in a perfunctory and passive attendance at "annual meetings."

Military engineering, with its infinite ramifications, is not a subject for treatment in a "one-volume" course. Each elemental component represents a case of specialized adaptation to military use of some parallel line of civil activity. Hence, while such a graphic and comprehensive series of lectures as engineers of the metropolitan district have recently been privileged to enjoy has done much to delineate broadly the general subject, for a more advanced, a "post graduate" course of study, a restricted field of effort becomes desirable and specialization essential.

Let the broad scope of the projected association for educational purposes be sectioned, and specific subjects assigned to and treated by departments. As possible divisions there may be instanced ordnance, high explosives, munitions, fortifications, submarines, aeroplanes, etc. A course of study in each department should include a comprehensive series of practical and detailed lectures, supplemented and expanded by frequent and informal conferences, and assisted by a selected course of reading.

Apart from the educational advantage of thorough familiarity with "the state of the art," and proficiency in the theory of the subject, which must accrue to each from co-operation in a departmental course, even more important are the results in the form of new development which may be anticipated—the natural outcome of mental induction and the stimulation of numbers on minds already proficient in the civil practice of their profession and who are now keen to adapt their specialized knowledge to military uses.

As a body this association should prove a source of considerable political influence. Free from all party allegiance, its collective power may be advantageously employed to advance all measures taken for national defense. Geographically, there should be no limit to the expansion of this association. Composed, as it will be, of members of the several national societies, with the co-operation of these societies little difficulty is to be anticipated in the ultimate establishment of flourishing branches in all of our larger cities. May we hope that the present committee will take action along the lines which have been suggested?

Small Irrigation Canals Lined with Concrete to Prevent Seepage Water Loss

Part I of Article Giving Details of Construction and Cost of Work on Okanogan Project in Washington

By C. E. EDWARDS
Civil Engineer, Okanogan, Wash.

As a result of lining with concrete about 40 per cent of the canal and lateral system of the Okanogan irrigation project in Washington seepage losses have been reduced from 51 to about 15 per cent of the total water received from Salmon Creek at the headworks, and an insurance against water shortage during seasons of minimum runoff has been provided. The lining has been placed in the sections of the canals where seepage losses were greatest, these locations having first been determined by current meter measurement. The economic feature of the improvement, as a conservation measure, is indicated by the fact that the annual runoff of the stream which feeds the system has varied from 56,500 to 17,350 acre-ft., a condition which calls for rigid curtailment of loss by seepage during periods of minimum yield. While information on the lining of large canals is not difficult to obtain, comparatively little is available on small canals and laterals such as those of the Okanogan project.

SEEPAGE LOSSES

The losses in the canal system for 1911, with 43 miles of canals and laterals in operation and only 1 mile concrete lined, was 51.1 per cent, an average of 1.2 per cent per mile of canals operated. The loss for 1915 was 20.4 per cent, with 76 miles of canals and laterals operated and 21 miles concrete lined, or an average of 0.27 per cent per mile of canal operated. Three small laterals carrying from 5 to 15 sec.-ft. have been all concrete lined. These laterals are from ½ to 1½ miles long, and a careful checking of the weir measurements of all the water turned in and turned out shows that there is practically no loss at all in these canals. About 4 miles of lining have been placed since the close of the 1915 irrigation season and another 1½ miles will be lined before the season for 1916 opens. It is estimated that this will reduce the losses in the system to less than 15 per cent for the season of 1916. The capacity of the canals concrete lined has varied from 1 cu. ft. per second up to 140 cu. ft. per second.

The seepage conditions on the Okanogan project are typical of a large number of irrigation systems throughout the West. Sooner or later, when the water becomes scarcer and more valuable, similar steps will be taken on these systems, not only to conserve the water supply but also to safeguard crops that would be injured by a lack of water caused by a serious break in the canal, which always occurs when the need for water is greatest and the canals are working to their maximum capacity.

The work of placing the concrete lining on the Okanogan project was started in the fall of 1911 and has been carried on in the spring and fall since that time. On account of having to do the work during the non-irrigation season, the time available in which concrete can be laid with safety from frost is reduced to 3½ months for each year. The work was not pushed the first two years on account of the high cost of getting cement in without railroad transportation. At that time cement on the work cost from $6 to $7 per barrel. The Great Northern Railroad was completed in 1913, and the cost of cement on the work was reduced to $3 per barrel and has been reduced as low as $2 since that time.

The methods and costs for 1911 and 1912 are not given, but the methods were similar and the costs higher than those for 1913-15, when the writer had charge of both the engineering and superintendence of this work under the supervision of the project manager.

DESIGN OF CANALS

In the original designs most of the canals were built with 1 on 1½ slopes on the upper portions of the project and 1 on 2 side slopes on the lower or sandier portions of the project. A friction factor of $n = 0.025$ was used in designing the unlined canals; a factor of $n = 0.015$ was found to be safe for concrete lining. The canals as already built and in operation were generally too large for lining without backfilling. A plaster lining 1½ in. thick was decided upon, with a backfill of sand and gravel of at least 3 in. on the bottom and side slopes.

The side slopes of the lining in most cases were made 1 on 1½, but some 1 on 1 lining was placed in the smaller ditches. On canals which had been constructed with a bottom width of 3 ft. or wider, and side slopes 1 on 1½, the amount of backfill required was from 4 to 8 in. deep, depending on the size of the canal. For canals with side slopes of 1 on 2 the backfill was sometimes 2 ft. deep near the top of the lining. This occurred only in sandy sections where the cost of the backfilling was comparatively cheap. On the smaller canals the amount of backfill required varied from 3 to 6 in. in depth.

In designing the cross-section a berm from 4 to 6 in. wide was made on all lining. This berm serves the double purpose of strengthening the top of the lining, and, by backfilling on top of it, prevents surface water from getting under the lining and filling up the backfill. In warm weather this would do no harm, but during the early spring, when the snow melts, a thaw during the day, followed by a hard freeze at night, will freeze the water in the backfill before it has had time to drain away, causing the lining to heave and crack.

Where the ditch is all in fill a 4-in. berm has been used with good results, but on sidehills, where there is considerable surface drainage into the canal, experience has indicated the need of a wider berm, and here a 6-in. berm, well backfilled on top, has proved very satisfactory.

When well-defined drainage channels entered the canal they were taken care of by lowering the side of the lining from 4 to 6 in. for a short distance, and widening the berm to 1 ft., so that the water could get into the canal without washing down and getting under the lining. Where necessary, pipe and rock drains have been made through the lower bank of the canal to drain the backfill.

GRADE AND ALIGNMENT

The center lines of the canals were run with a transit and stakes set every 10 ft. These stakes were then driven to grade and care taken to keep them in line, as the same stakes were used for line and grade. The hubs were set on the grade of the top of the backfill so that a template could be set and centered on these hubs to act as a guide in placing the backfill. By setting the grades this way it is not necessary to move them when the lining is placed. After the backfill had been placed and flooded, and before the final finishing to neat lines preparatory to plastering, the grades and alignment were checked.

SHAPING CANALS TO PROPER SECTION PRIOR TO PLACING OF CONCRETE LINING—SHOVELERS REMOVING EXCESS MATERIAL FROM TRENCH BOTTOM

When new canals were constructed with the idea of lining immediately, they were excavated to neat lines and a minimum thickness of 3 in. of backfill placed. But where canals had been in use it was necessary to cut off the overhanging sod berms, even where the cross-section was being reduced, in order to guard against any settling away of the backfill under these overhanging berms.

WORKING CREW

The crew for this work consisted of a foreman with from 10 to 20 laborers, depending on the size of the ditch and the amount of material that was required to be moved. The efficiency of the crew was considerably reduced if the men were strung out over a long section of canal.

In determining the amount of material to be removed, if any, two men worked ahead with a template to which a carpenter's level was attached. They excavated trenches at each grade hub, these trenches being taken out to the neat lines of the section, as it should be before the backfill is placed. The excess material between the trenches was removed by the remainder of the crew, each man taking a 10-ft. section, which kept the crew as nearly together as it was possible for them to work to advantage and tended to increase the efficiency of the crew by making it easier for the foreman to check up the quality and quantity of each man's work. No straight-edge was used on this work, as extreme accuracy was not necessary. It was the duty of the foreman to see that the men handling the template used care in centering and leveling it on each hub and also to see that the template was held vertical and at right angles to the center line of the canal. This is very important on sharp curves, if a good job is to be obtained.

HAULING AND PLACING OF BACKFILL

The irrigable lands of the Okanogan project are underlaid with sand and gravel to an unknown depth. The soil is from 1 to 10 ft. deep, probably averaging 2 ft., and below this lies sand and gravel which has been deposited in various slopes and positions, so that it is almost impossible to tell what grade of material will be encountered without digging test pits at very close intervals. A good grade of sand and gravel can be found along the canals at irregular intervals. It is seldom necessary to haul either sand or gravel more than 1 mile for backfill material or aggregate for concrete.

The backfill material was hauled and dumped on both sides of the canal, wherever possible, in order to save passing it across by hand. Where necessary, temporary bridges were constructed for the purpose of getting the material dumped on both sides of the canal and they also saved considerable time in getting equipment and other material back and forth along the cut where the banks were too narrow for teams to turn.

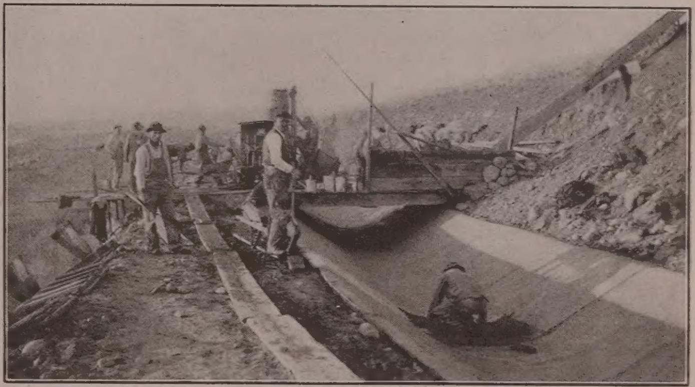
On account of the small yardage handled from each pit it seldom paid to build a loading trap, so that most of the material was loaded by hand. From 6 to 12 shovelers under a sub-foreman were employed in the pit, depending on the room available and the grade of material being handled. Each teamster helped to load his own wagon. On account of lack of roads to haul over and hard places to get into only 1 cu. yd. was hauled per load. The average length of haul for this material was about ¼ mile.

When the backfill was hauled the size of the placing crew varied from 6 to 12 men, under a sub-foreman, the size depending on the amount of material available and whether it could be dumped on one or both sides. Where the amount of backfill required was available it was necessary for the placing crews to keep well up with the hauling in order to avoid a shortage or oversupply of material in any one place. One of the placing crew helped the teamster to dump his load, as dump boards were used entirely on this work. No dump wagons were employed as the teams were all hired from water users and they used their farm wagons fitted up with dump-boards of 1-cu. yd. capacity.

In placing the material 3 men with a template went ahead and at each grade hub they put the backfill in up to grade just even with the template all around. These 3 were followed by from 3 to 6 others and the sub-foreman, who filled in between the hubs until the slope projected inward a little beyond the template line. The sub-foreman worked with his men and used his judgment as to how much extra material was needed after flooding prior to the concrete lining work. For a backfill 6 in. deep it was usually necessary to place about 6½ in. of sand and gravel mixed or 7 in. of coarse sand. Where the backfill material could be taken out of the upper bank, which was possible on about one-third of the work, one sub-foreman could handle 30 men to good advantage. Each man was given a 10-ft. section to fill and the foreman checked up each section as it was finished and sent the man ahead. In this way no slack work was done and no unnecessary material was put into the canal that would have to be removed when finishing.

FLOODING AND FINISHING BACKFILL

After a section which was to be lined had all been backfilled it was flooded as near to the top of the canal as safety would permit. Where there were no permanent checks sack dams were built at regular intervals and the water was backed up in this manner. The distance between these dams varied from 200 to 1000 ft., being governed by the slope of the canal. Only a small amount of water was used in flooding and this was let in slowly to avoid washing the backfill down from the slopes. The dams were all constructed before the water was admitted, and after the first dam was full the water was allowed to run over the top so that the first section could be soaking while the lower sections were being filled. After the upper section had been soaked a couple of hours the work of taking down the dams or lowering the checks was started, the upper dam being taken down first. This was done slowly so as not to release too much water and wash the backfill in the lower sections or cause the water to be lowered too fast above the dam, as this had a tendency to make the backfill slough down off the slopes if there was a large proportion of sand in the material used for that purpose.



WHERE POSSIBLE THE MIXER WAS LOCATED AT THE SIDE OF THE TRENCH, BUT SOMETIMES IT WAS NECESSARY TO CARRY THE PLATFORM ACROSS THE CANAL

After the water had drained out the finishing was started as soon as possible, usually the next day. This work was handled by a crew of from 12 to 15 men, under a sub-foreman, who were organized as follows: Three men went ahead with a template, which was fitted with a carpenter's level. This template was the exact size of the neat section of the canal before the lining was placed. It was centered and leveled over each hub and set at right angles with the center line of the canal. Then thin strips, usually 1 x 2 in. or 1 x 3 in., were inserted under each side of the template for the straight-edge to slide upon. These strips were 2 in. longer than the sides of the template and the upper ends were set flush with the top of the template, the bottom ends being pressed into the backfill so as to hold them in place. The strips were then firmly embedded in the backfill by tamping the material under and against them with shovels. As soon as this had been completed the template crew moved the template on to the next hub and so on down the canal, sufficient strips being provided for 25 or 30 hubs. The rear hubs were carried ahead as the straight-edging was completed.

STRAIGHT-EDGES SMOOTH SIDES

As soon as the template crew was out of the way two straight-edge crews were started. These crews consist of three men each, one crew working on either side of the canal. The straight-edges were made of 2 x 4-in. by 12-ft. pieces, planed smooth on all four sides. One man worked on each end of the straight-edge and the third man stood between with a shovel and removed the excess material away from the bottom, when necessary, and filled up any hollow places that occurred on the slopes as the straight-edging was done. The straight edge was run flat the first time and the last couple of times it was run on edge to take out any bow in the slopes.

After the side slopes had been straight-edged down so that they were in the same plane as the strips that had been placed by the template crew, the straight-edge was set on top of the strips and pressed back on the berm so as to leave the top of the berm level and smooth, at least 6 in. wide, and on the same grade as the top of the strips. On narrow-bottom canal one straight-edge crew worked two or three sections ahead of the other, on the opposite side, so that they would not interfere by being in each other's way.

EXCESS MATERIAL REMOVED

Following the straight-edge crews were from 3 to 6 shovelers who took the excess material out of the bottom of the canal and away from the edge of the berm and leveled the bank ready for laying running boards. On canals with a bottom width of 4 ft. or less no attempt was made to straight-edge the bottom, but the shovelers were followed by a man with a square point shovel who leveled up the bottom and squared up any rounding corners at the junction of the bottom and side slopes. This work is important, as any rounding corners which may be left will hold the bottom of the plasterer's straight-edge out and cause a kink in the alignment of the side slope at this point and in addition will make the lining thicker and cause a waste of material. If these kinks occur at frequent intervals they will set up cross currents in the canal and reduce its capacity to a very appreciable extent. This is more particularly true of small canals having a steep grade and a high velocity.

(To be concluded.)

Irrigation Laws Developed in California

Radical Changes Have Been Made Since the First Legislation Was Passed in 1887—Irrigable Land Now 21,000,000 Acres

AFTER thirty years' experience with irrigation projects, California has tried out and improved irrigation district laws until a system has been developed which in recent years has been frequently copied by other states. A considerable number of large irrigation districts have been well established and are now operating successfully. Among these are the Modesto, Turlock, Oakdale, South San Joaquin and Alta districts. Numerous smaller districts are none the less active, and a great many others are now in process of organization. Each district is a political entity and is recognized as a political subdivision of the state.

The laws authorizing the organization of these districts have undergone radical changes since the first irrigation law was passed in 1887, but their constitutionality and the validity of the bonds they issue has been upheld by test cases carried through to the United States Supreme Court. As the law now stands, before an irrigation district can be organized in California, the state engineer must approve the adequacy of the water supply and the plans outlined for the irrigation system; the county board of supervisors in which each district is located must authorize the organization of the district, and the voters are allowed to exercise full governing power over its affairs.

LEGAL STATUS

Except for purposes of organization, there is in California little difference between a school district and an irrigation district. The payment of principal and interest in both instances is assured by the sovereign power of taxation. All bonds of the irrigation districts are rated as legal investments, and under the ruling of the Treasury Department the income from these bonds is exempt from all state taxation, as well as from federal income tax, and individuals need not report the income derived therefrom.

The board of directors of each irrigation district has power to levy taxes to meet principal and interest in all outstanding bonds, and this tax ranks on a par with all taxes raised for city and school district purposes. The bonds for each district comprise a direct first charge on all real estate in their respective boundaries. Tax records show that of the $5,379,037 levied in this manner only 0.4 per cent were allowed to become delinquent. This percentage is less than that in many California cities. Of the $12,000,000 of irrigation bonds issued in California since 1897 there has been no default in the payment of principal and interest.

IRRIGABLE AREAS

It is estimated that the total area of land in California susceptible of irrigation is about 20,865,000 acres. Experiments reported by state and federal research bureaus state that these lands require from 1 ft. to 5 ft. in depth of water applied each year to obtain the best results. The quantity varying, of course, with the soil, kind of crops, locality, etc. Compared to these irrigable areas, reports of the geological survey and the state engineering department indicate the total average flow of all streams of the state to be annually about 60,000,000 acre-feet, or nearly 3 ft. per annum for all arid lands.

The Central Irrigation district, which was the first to be formed in California, was organized in 1887. It voted bonds for $750,000 and involved an area of 156,550 acres. This district and a number of others which followed in rapid succession in the next four years were not successful. The lack of success, however, was not because irrigation was not required on their lands, or because the projects were not feasible, but rather because of the loose manner of doing business and internal opposition. For example, in the $80,000 bond election affecting 13,000 acres of land in the Kraft district unanimous approval was given to the proposed issue. The total number who voted at the election, however, was nine.

In the past 15 years 62 irrigation districts have been formed in California, involving a total area of almost 3,000,000 acres, and under the recent amendments to irrigation district laws there has been a very great increase of activity in the formation of new districts. Residents of the Anderson-Cottonwood district of Shasta County, which is in the Sacramento River basin, are just completing the organization of a district which includes 30,000 acres of irrigable land. A bond indebtedness of $400,000 has been voted to purchase water rights and construct an elaborate system of ditches. The Imperial Valley Irrigation District in southern California is probably the largest and most important ever organized in the West. An account of the transaction involving $3,500,000, whereby the district took over the properties of the California Development Company, appeared on page 707 of the Engineering Record, issue of Dec. 4, 1915. The Carmichael and Paradise districts in the northern part of the state are both seeking to perfect their own organizations, and the West Side Irrigation District at Tracy will vote upon a bond issue at an early date.

Upper Pit River basin	180,000 acres
Feather River basin (Alpine valleys and hills)	158,000 acres
Foothills	565,000 acres
Sacramento Valley	2,400,000 acres
Scattering	2,000 acres
Total	3,305,000 acres

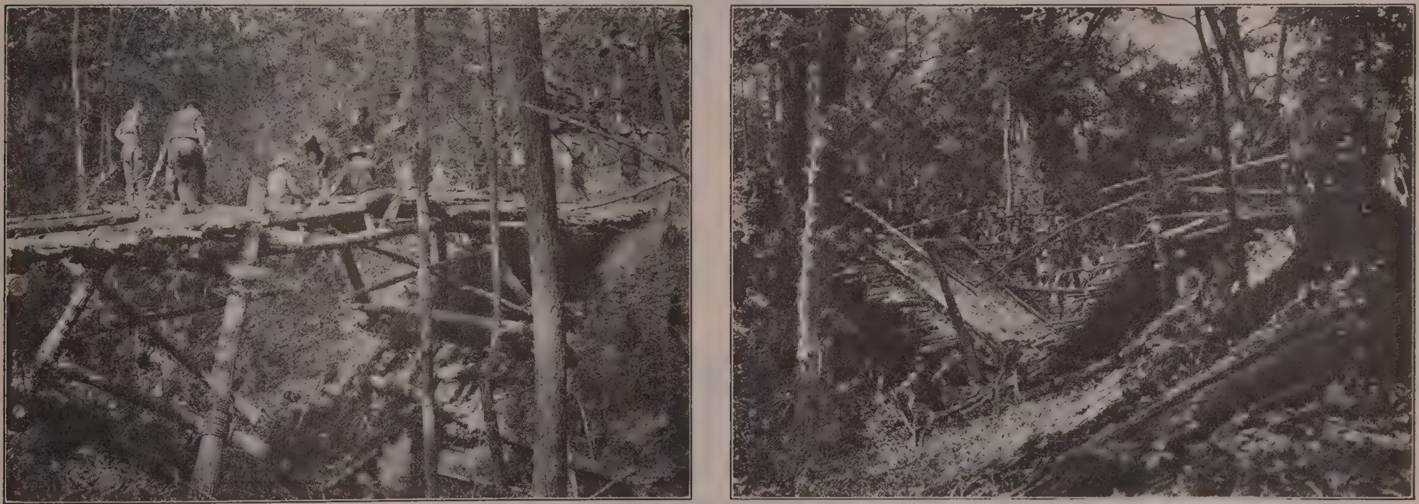
The reclamation service co-operating with state authorities has reported that the Iron Canyon project on the Sacramento River would permit of storing 600,000 acre-feet of water for irrigation and power. This project, if consummated, would become a factor in flood control that would affect the lower reaches of the river. Other dam sites in the mountains have been examined by the reclamation service, whose total storage capacity is estimated to be 7,000,000 acre-feet.

A STANDARD SCORE CARD has been issued by the Utah School Buildings Commission for the use of inspectors of school buildings in the State. All the desired information is classified and the inspector simply rates the conditions found on the basis of ten as perfect. Details for inspection are given in thirty-six items, under the following main divisions: site, building, class rooms, cloak rooms, heating apparatus, ventilation, toilets and water supply, and janitor service.

National Defense—For Engineer and Contractor

Seventh Article in Series Describing Demolitions with Fire and Explosives and Methods of Conducting Siege Operations

By Major P. S. BOND
Corps of Engineers, U. S. Army



DOUBLE LOCK SPAR BRIDGE CONSTRUCTED ENTIRELY OF MATERIALS OBTAINED AT SITE AND DEMOLISHED SOON AFTERWARDS BY AN EXPLOSIVE CHARGE

DEMOLITION is always an important accessory of tactical operations. It serves to hamper the movements of the enemy, to frustrate his plans and, by the removal of obstacles, it facilitates the operations of our own forces. Demolition on a large scale, except in emergency, should not ordinarily be permitted without the express order of a responsible commander, as otherwise military expediency may degenerate into vandalism. Ill-timed or premature destruction may involve very unfortunate consequences.

FIRE AND EXPLOSIVES

As in all the operations of war, so in military demolition there is demanded adequate results in the minimum of time. Demolition is the particular function of the engineer troops, but as it may be required at any time in any part of the theater of war all troops are now equipped with demolition outfits. These outfits must necessarily be simple, light and portable, while capable at the same time of producing powerful effects. The means of demolition best adapted to military requirements are fire and explosives. The former requires no equipment, the latter provides a powerful instrument of light weight.

Demolitions are frequently accomplished by the fire of high explosive shells from large guns. Indeed, for the destruction of hostile fortifications and obstacles protected by the hostile fire, this will often be the only practicable means. It is, however, always expensive and often uncertain and inapplicable. Where it is possible to place charges of explosive judiciously, greater, more certain and more prompt results can usually be obtained.

The advances made in recent years in the manufacture of high explosives have placed a powerful weapon in the hands of the military. But knowledge and experience in the effective practical use of explosives is not common, and it is very important that all officers, and especially engineer officers, should be fully instructed in practical demolition. An explosive for military demolitions should be: (a) Stable for long periods; (b) unaffected by ordinary variations of moisture and temperature; (c) not unduly sensitive to shock in handling, transportation, etc.; (d) not unduly difficult to detonate; (e) quick enough to give good results even when unconfined; (f) convenient in form and consistency for transportation and use under field conditions.

These requirements call for a high explosive of medium strength, solid in consistency, and put up in damp-proof packages of standard size. A number of commercial explosives meet these requirements fairly well, and none is invariably preferred to the exclusion of all others. It will be a question, usually, as to which can be most readily obtained in sufficient quantity. Among these explosives are gun-cotton, nitro-glycerine, dynamite, jovite, the picrates, fulminates, Sprengel safety mixtures, gunpowder. Dynamite is the most common commercial explosive and is well adapted to military uses. Nitro-glycerine is dangerous in handling and transportation because of its liquid form. The fulminates, particularly mercury fulminate, are especially useful as detonators for other explosives because of the abruptness and violence of their action. They are accordingly extensively used for caps, primers, etc.

Explosion is produced by detonation, for which purpose a small cap or primer of fulminate is inserted in the charge. The cap may be fired by means of a powder fuse or by electricity. The latter is the preferred method, but requires a magneto-electric exploder and lead wires. If these are not available the fulminate may be ignited by means of a powder fuse. Two classes of fuse are employed, time and instantaneous. They are distinguished by the color of their wrappings. Time fuse burns at the rate of about 3 ft. per minute; instantaneous fuse, 120 ft. per second. Caps and fuse must be kept away from other explosives.

Charges should be tamped in some manner whenever this is practicable, as their effect is thus greatly increased. Timbers should be bored to receive the charge when practicable. Charges placed to destroy concrete, steel, etc., should be tamped with earth or mud. If tamping is impracticable the charges must be increased. Skill in placing the charge will greatly increase its effect. Several small charges judiciously distributed will often produce better results than one large charge, but care must be taken to insure simultaneous detonation.

HOW STRUCTURES ARE DEMOLISHED

In the case of an important demolition a reconnaisance or examination should, if practicable, be made to determine the extent of the destruction required and the easiest, surest and most expeditious manner of accomplishing it with the men and equipment available. The damage inflicted should be sufficient for the purpose in view and no more. If the purpose is merely to delay for a short period the use of a certain bridge it may be sufficient to remove the deck instead of destroying the trusses. A telegraph line may be temporarily interrupted by cutting the wires, but for complete demolition the poles should be cut down and burned. In the case of railroads, which are frequently attacked, it is easier to demolish a bridge than to tear up track, but it is much more difficult to repair the damage in the former case. It is as easy to remove a rail on a curve as on a tangent, but it takes more time to prepare and place a curved rail. The proper charges of explosives to accomplish certain results have been determined by experiment and are given in the manuals. They serve as a useful guide, but cannot take the place of experience and good sense.

The following notes will indicate the methods employed in some of the important military demolitions:

All timber structures may be destroyed by fire. For rapid work they may be sprinkled with coal oil, tar, or other inflammable liquid before ignition. Framed structures of wood or steel may be destroyed by attacking the weakest members of the framing. In a truss bridge the chords may be cut at their thinnest points. Bridges are most effectively demolished by overthrowing their piers or abutments, which wrecks the entire structure. The most vulnerable points of roads and railroads are the important bridges or viaducts. Railroads may also be attacked at culverts and tunnels. If these vulnerable points cannot be reached, railroads may be interrupted by removing rails, preferably on curves. A fire is made of the ties, the rails placed therein and twisted while hot. An entire section of track may be removed by opening the joints at each end, loosening the ballast and then overturning the section. It is best to select an embankment and throw the loosened section down the slope. Railroads may be crippled by removing or wrecking the rolling stock, especially locomotives, by demolishing switches and water tanks. It is generally better to wreck the road at several points rather than to concentrate the work of destruction in one locality.

Highways are very difficult to destroy, but the passage of vehicles may be interrupted by digging trenches across them, by firing land mines in the surface or filling deep cuts with debris. Buildings may be demolished by closing all openings and firing a large charge in a central position. Telegraph lines may be interrupted by cutting the wires, but for complete demolition the poles should be cut down and burned, which also destroys the cross arms and insulators. At stations the instruments are removed or demolished and the records seized.

Woods are rendered useless as cover by fire or by cutting down the trees with tools or explosives, lopping off the branches and throwing them into ravines. The trunks may be left on the ground and it is neither necessary nor practicable to remove the stumps, as it takes too much time.

Masonry arches may be attacked by explosives at the haunches or crown. In a multiple arch bridge the destruction of a pier involves the two adjacent arches. Locks are rendered useless by destroying the gates or filling valves. Supplies and materials of all kinds are ordinarily destroyed by fire, after sprinkling them with inflammable liquid, or mixing inflammable and non-inflammable materials.

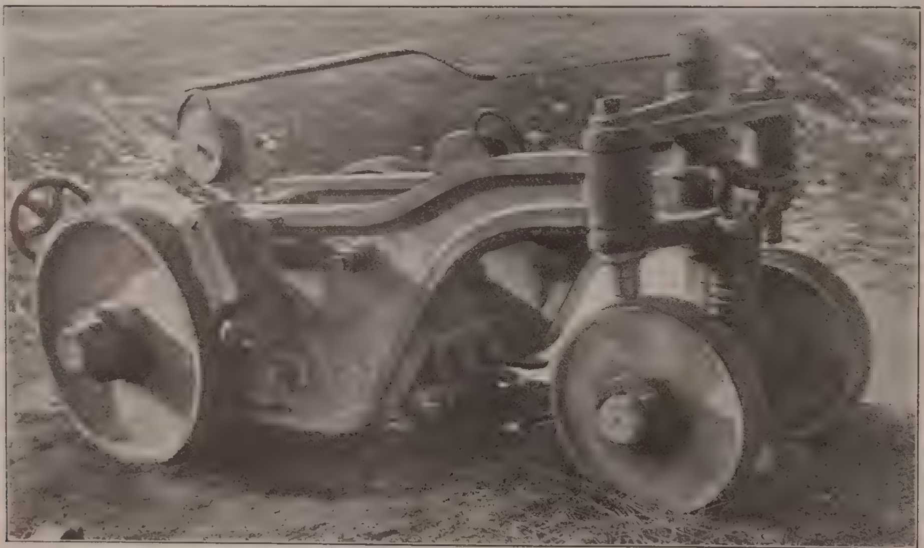


Photo. Underwood & Underwood

THIS MACHINE WAS HAULED BY THE RUSSIAN ARMY TO TEAR UP THE ROADS OVER WHICH THEY WERE RETREATING AND MAKE THEM IMPASSABLE FOR THE PURSUING GERMANS

Barbed Wire Entanglements

Obstacles placed in front of trenches are very difficult to destroy because they are deliberately constructed with that end in view and are under the fire of the defenders of the trenches. They are often demolished by shells and grenades, but such methods are slow, expensive and unsatisfactory. Wire entanglements are the most effective of all obstacles and the most difficult to destroy. They may be cut with nippers under cover of darkness or behind a steel shield. The process will usually be accompanied by heavy loss of life. Often it will be better to bridge over the obstacle with bundles of brush, hurdles, plants, sections of board-walk specially prepared, etc.

Siege Operations

The increasing power of modern firearms has tended toward the obliteration of the sharp distinction between siege and field operation. Important localities whose strategical value can be foreseen are still fortified, however, in times of peace. Such defensive works are very elaborate and of great strength and they are provided with every conceivable device and facility for resisting attack. An assault upon them has little prospect of success unless the works have been at least partially demolished, inasmuch as they present great physical obstacles and afford such thorough shelter to the defenders that it is difficult to shake their morale or diminish the effectiveness of their fire by means of rifles, machine guns or light field guns. The defenders will also be provided with ordnance of the most powerful types, they will be intimately acquainted with the foreground, which is specially prepared in advance to embarrass the attack, and they will possess large supplies of ammunition and excellent facilities for its storage and use. The fire of the defenders and their protection will, therefore, be more effective than is possible with less formal preparation.

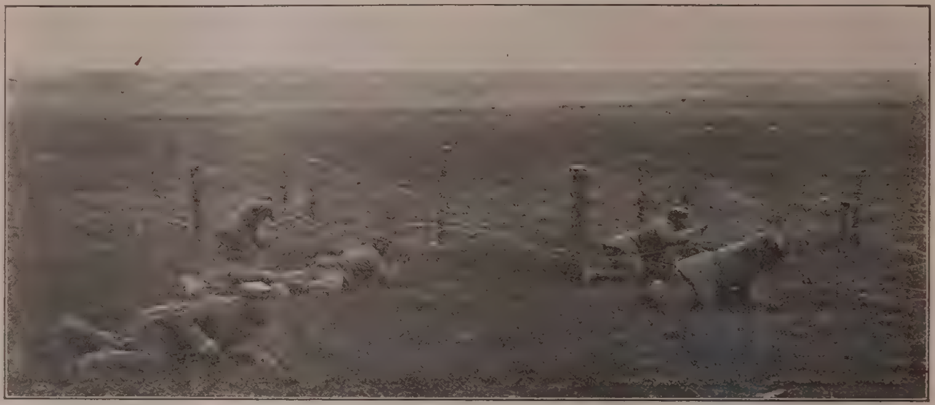


Photo. Press Illust. Co.

THE BARBED WIRE ENTANGLEMENT HAS PROVED TO BE AN EFFECTIVE MILITARY OBSTACLE — IN THIS PICTURE GERMAN TROOPS WITH WIRE CUTTERS ARE ENDEAVORING TO REMOVE THE OBSTRUCTION

Such fortifications must generally be thoroughly demolished before their defenders can be dislodged, and for this purpose guns of large caliber, hurling great charges of explosives, are required, coupled often with extensive mining operations such as have been described in a previous article of this series.

Reducing a Fortress

The first step in the reduction of such a fortress, which should be carried out if practicable, will be to cut off its supply and reinforcements as well as its communication with the outside world by surrounding the place with a line of troops. This is called the line of investment. It should generally be drawn as close to the fortress as the effectiveness of the defenders' fire will permit. It is not necessarily continuous, but must usually be fortified. The investing troops may have to resist attack from more than one direction, inasmuch as the enemy may endeavor to break the investment by sorties of the garrison of the fortress, or by the attack of a field army operating in conjunction with the garrison. If the civil population has not been previously withdrawn they are compelled by the besieger to remain in the fortress in order the more rapidly to exhaust its food supplies.

The investment having been completed or found impracticable, one or more points of the fortress are selected for the formal attack. If the attacker is well supuplied with heavy ordnance the works may be generally demolished and rendered untenable by a vigorous bombardment.

The points selected for attack will be those where the fortifications appear to be weakest, where the attacker's fire may be most easily concentrated, where the foreground is most favorable for his operations, where he is least apt to be interfered with by sorties or attacks from the outside, or where the consequences of success will be most disastrous to the enemy, etc., etc.

Zigzag Trenches Advanced

The heavy guns are then emplaced and the bombardment commenced. When the defenders' artillery has been brought under control an attempt is made to break out an infantry trench as close as practicable to the fortress. This is called the "first parallel." Zigzag approaches are pushed forward from the first parallel and a second parallel is broken out. To avoid as far as possible the enemy's fire this work is usually done at night—all in one night if practicable. Successive parallels are thus established and pushed as close to the enemy's works as his fire will permit. Meantime the operations are covered and the fortress damaged as much as possible by a practically continuous bombardment. From the last parallel mines are driven forward to demolish the works. The enemy will oppose these operations with fire, by sorties of the garrison and by countermining operations against the besiegers' works. A breach in the fortress having been effected by bombardment and by mining, the besieger delivers an assault from the last parallel, supported by the fire of his artillery.

The various means for reducing a fortress, therefore, are:

(a) Starvation as to ammunition, food supplies, etc.

(b) Demolition of the works by the fire of large caliber guns and by mining.

(c) Assault of the works from a trench or "parallel" established as close as practicable.

These methods may be employed singly or in combination, depending upon the strategical situation, the purpose in view and the circumstances of the case. Successful assault will usually, however, be impracticable without a previous bombardment.

[*Mobilization of the nation's material resources will be the subject of Major Bond's next article.*—Editor.]

Master Piles Eliminate Rangers in Deep Steel Sheet-Pile Trench

Staten Island End of Narrows Siphon, New York City, Built Under Water Near Existing Structures in Specially-Designed Open Trench

THE necessity for excavating a deep trench close to an existing pier in connecting the Staten Island end of the water supply siphon across the Narrows in New York Harbor to the work in Arrietta Street created an unusual problem that was solved by a submarine trench constructed without waling through the use of a novel design of steel sheet-piles.

The Narrows siphon, a 36-in. cast-iron flexible-joint pipe line which will carry Catskill water from Brooklyn to Staten Island, as described in the Engineering Record of Dec. 19, 1914, page 656, was laid by a derrick scow equipped with a special skidway on which the joints were made above water and down which the pipe slid into a dredged trench as the derrick scow progressed across the Narrows. It is planned to slide the end section of the line, connecting to the main in Arrietta Street, down a skidway in the same manner, but, owing to existing water-front improvements, a channel could not be dredged to accommodate the boat which laid the rest of the line. At the same time, to keep the pipe out of harm's way, deep excavation was required up to the Staten Island bulkhead line, alongside of an existing box sewer and close to the pile-supported warehouse of the American Dock Company. Open trench construction, with steel sheet piling to retain the dirt, and a skidway supported from the piling down which this section of the pipe line could be slid as it was assembled and calked on shore, was decided on. It was thought best to make the closing joint with divers, to avoid pumping a closed cofferdam including the end of the line already laid, as the outer end of such a cofferdam would have been in deep water under more than 50 ft. head, which would have made its construction and maintenance costly. At the same time, if the structure were not to be pumped, it was realized that to place ordinary waling and bracing (to resist the earth pressure) under water with sufficient accuracy to permit laying the skidway on an even grade would be most difficult.

Master Pile Construction Developed

This difficulty was overcome by supporting the steel sheeting in a series of arcs from master piles, which are braced against each other across the trench by timber struts. These struts rest on shelf angles, bolted by divers to the master piles after driving. The stress produced by earth pressure between the master piles is transmitted to them through the interlocks of the standard sheet piles making up the trench wall. This arrangement, shown in the accompanying drawing, not only made possible the construction of the skidway to an accurate grade, but facilitated dredging out the trench, because digging could be done against the sheeting, handling the bucket at high speed without fear of ripping out the bracing.

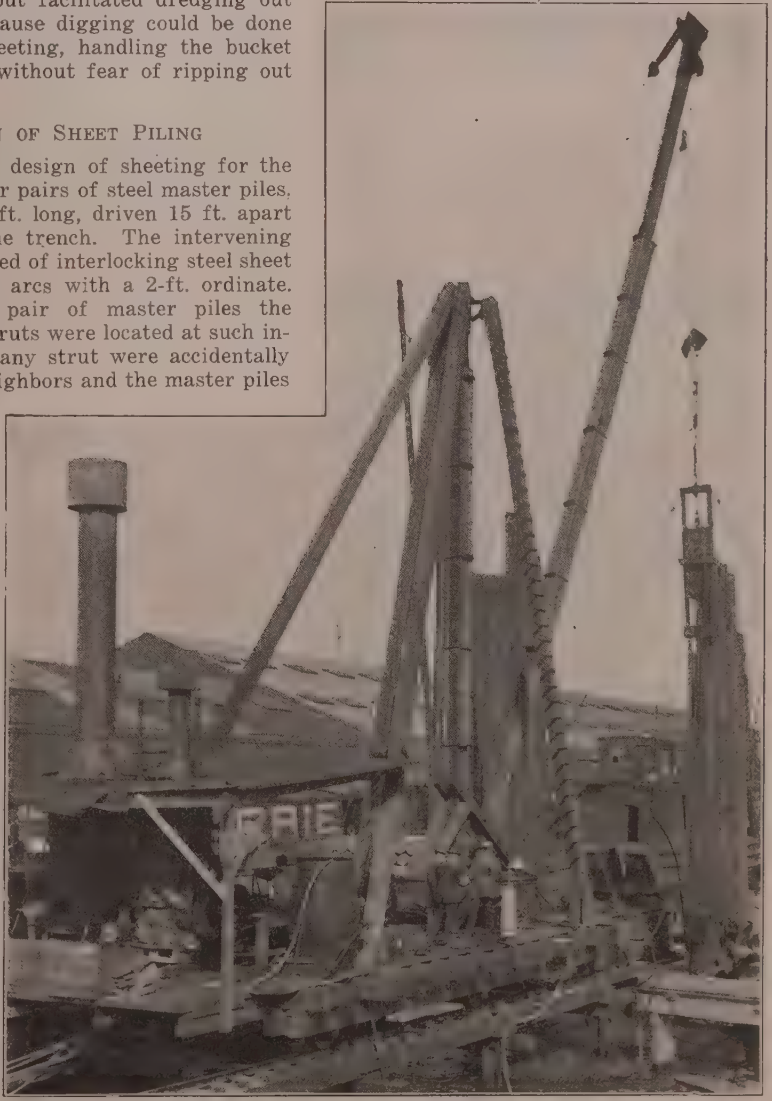
Design of Sheet Piling

The accepted design of sheeting for the trench called for pairs of steel master piles, from 35 to 65 ft. long, driven 15 ft. apart in line with the trench. The intervening bays were formed of interlocking steel sheet piles driven on arcs with a 2-ft. ordinate. Between each pair of master piles the wooden cross struts were located at such intervals that if any strut were accidentally displaced its neighbors and the master piles would not be over-strained. The lateral pressure at the toe was taken care of by a similar strut placed below the pipe-line grade, both master piles and sheet piles extending 9 ft. below the excavation to protect the bottom. Wedges were placed at the ends of each bottom strut, the pipe cradle being suspended from the next strut above, so that upon completion of the pipe laying these wedges could be withdrawn and the master piles pulled without disturbing the pipe.

In the out-shore bays the outside material slopes down to within about 20 ft. of pipe-line grade and the difference in longitudinal pull due to its decreasing pressure is taken up by a pair of longitudinal timbers placed outside the master piles as close to the bottom as possible. East of the last master pile the interlocking sheet piles are driven flaring outward so as to breast sufficient material to resist the final longitudinal pull. In the westerly bays the friction of the outside material and two lines of shallow sheet piles extending beyond the first pair of master piles compensate for the decreasing longitudinal pull due to the up-slope of the trench at that end.

Pressure Conditions Assumed

A design for the steel master piles was prepared considering the outside material to act as a fluid, but observation of this material showed an assumed angle of repose of 1 on 2 to be safe if motion were prevented. The adopted design was modified correspondingly, the weight of the immersed outside material being taken at 60



A SPECIAL TRAVELER WAS DEVELOPED FOR HANDLING THE LONG SHEET PILE SECTIONS ON THE NARROWS SIPHON OF THE CATSKILL AQUEDUCT—SOME OF THE MASTER PILES WEIGHED 4 TONS lb. per cubic foot acting under the Rankine formula for earth pressure. This gave a maximum bending moment on the master piles of about 200,000 ft. lb., a maximum compression on the critical bottom strut of 118,000 lb., and a maximum horizontal tension on the sheet-pile interlocks of 1300 lb. per lin. in. For the master piles 18,000 lb. per sq. in. flange stress and 12,600 lb. rivet shear were allowed, and for the oak struts in compression 820 lb. per sq. in. Below the excavated portion of the trench it was assumed that the material between toes was stiff enough to transmit the pressures on it.

4-Ton Master Piles

The master piles, some of which weigh 4 tons each, have a section modulus of 131 in.,^{3} each web being composed of one 12-in. I-beam weighing 50 lb. per lin. ft., the inner flange being a 12-in. channel weighing 25 lb. per lin. ft., and a standard 12½-in. pile weighing 38 lb. per lin. ft., with ball and socket edges bent inward, making up the outer flange. All three elements were riveted together columnwise with ⅞-in. rivets on 3 to 4½-in. centers. The main beam section was selected on account of its thick web, which was designed to resist any eccentric thrust of the cross struts. It was also realized that a chunky section was needed to withstand fabricating strains involved in bending the pile element. The tops were reinforced with heavy ⅝-in. plates to distribute the blow of the driving hammer, and at each point where the 12 x 12-in. struts occurred rivet heads were countersunk on the back of the 12-in. channel, and open holes provided for loose heavy angle brackets, extra holes 3 in. above and below the theoretical location, taking care of possible irregularity in driving. At the top of each master pile was riveted an angle bracket for the reception of a 12 x 12-in. timber cap strut on which to lay track for a traveling pile driver. A pair of 1-in. diameter sway rods in the bent directly beneath stiffen the structure crosswise against vibration. The six easterly pairs of master piles were provided with heavy vertical angles riveted outside the pile element in suitable lengths to receive the 10 x 10-in. longitudinal timbers taking up the differential stresses. Four 1⅜-in. pulling holes were drilled through the web-reinforcing plates in the top of each master pile. All these details were riveted on with vertical projections so as not to impede driving.

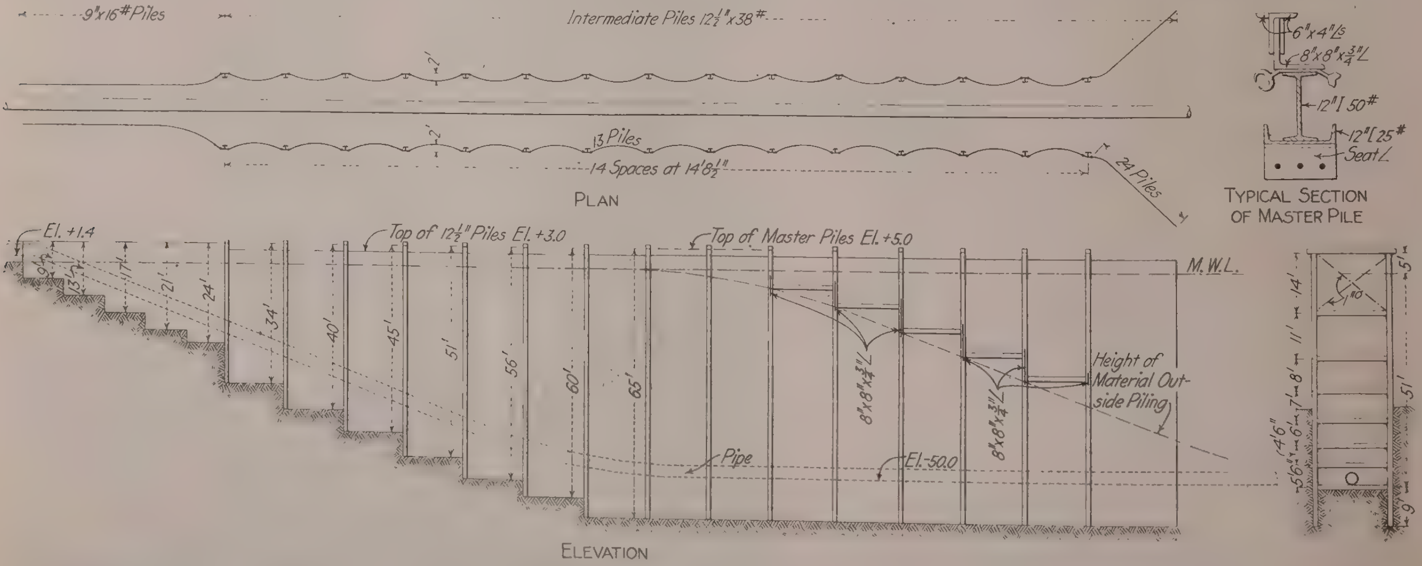
The interlocking steel sheet piles in the curved bays between the master piles were of the United States type, 12½ in x 38 lb., weighing about 35 lb. per sq. ft. They varied in length from 32 to 63 ft., the heaviest single piece weighing about 2400 lb. The interlocks of these piles are required to show a strength in tension of not less than 9500 lb. per linear inch. Every alternate pile driven through the deepest material was furnished in two lengths, with splice plates and bolts to facilitate handling without an unnecessarily long boom. These piles were also provided with pulling holes.

At the westerly end of the trench the rising grade of the pipe-line required sheeting not deeper than 24 ft., and here United States interlocking steel sheet piling, 9 in. x 6 lb. per lin. ft. was provided to be braced in the usual way without any master piles. The tops of the master piles are 5 ft. above datum, and the tops of the sheet piles are 3 ft. above datum, it being considered desirable to keep these tops in plain view in order to detect any unforeseen movement beneath.

The construction of the trench and of the pipe line required the use of several new methods and resulted in the development of the special traveler shown in the accompanying photograph. The work will be described in detail in a later article.

Personnel

The Merritt & Chapman Derrick & Wrecking Company is building the Narrows siphon for the Board of Water Supply of New York City, of which J. Waldo Smith is chief engineer, Alfred D. Flinn deputy chief engineer, Walter E. Spear department engineer, and John P. Hogan engineer in charge of the division including the work. Edward H. Hopson is in direct charge for the Board of Water Supply as resident engineer on the contract. The construction work was planned by William L. Chapman and Ralph E. Chapman, members of the contracting firm, and is being supervised by the latter, for whom Captain Tooker is in charge at the job. The traveler and skidway were designed by Long & Miller, engineers, of New York City. The steel sheet piling, including the master piles, was furnished by the Carnegie Steel Company, whose New York engineer, Fred T. Llewellyn, is responsible for the general design and details of the steel trench construction. This design was checked by the Board of Water Supply under the direction of Thomas H. Wiggin, its senior designing engineer.



THE STEEL SHEETING IS SUPPORTED IN A SERIES OF ARCS FROM MASTER PILES, BRACED AGAINST EACH OTHER ACROSS TRENCH BY TIMBER STRUTS

Elm Roots Clog Sewer

A ROW of elm trees 20 ft. distant and parallel to a 6-in. sewer was the cause of the complete stoppage of flow in the line. This sewer was laid in Concordia, Kan., in 1903 and in November, 1915, when it was dug out, the pipe was found filled for a length of 200 ft. with elm roots varying in size from ¼ in. in diameter to the size of a pin. The tile were of the usual vitrified, bell-and-spigot type, and close examination showed that very little attention had been given at the time of construction to making water-tight joints. As a result the elm roots soon entered the sewer through the joints in the pipe and finally destroyed its usefulness as a drain.

ROOTS WHICH BLOCKED SEWER PIPE

The accompanying photograph indicates what a solid mass the roots had formed. It gives sufficient reason, according to Black & Veatch, the consulting engineers of Kansas City making the examination, for those engineers who have made a practice of rigidly inspecting joints in sewers and of insisting that the greatest care be exercised in making these joints.

Dynamite, Oxy-Acetylene, Fire and Cranes Required to Wreck Concrete Bins

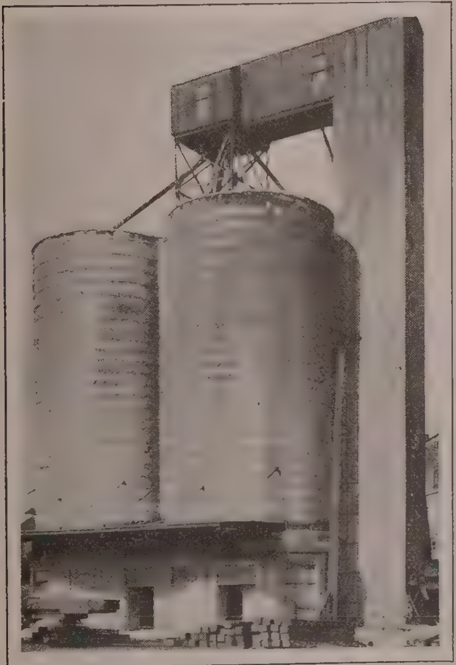
1000-Ton Structure Falls 12 Ft. on Edge Without Apparent Damage—Reinforcing Nullified Effect of Blasts in Supporting Columns

DYNAMITE, oxy-acetylene torches, fire and wrecking cranes were employed successively in razing five tall, thin-walled, reinforced-concrete, cement storage bins, built fifteen years ago at South Chicago. Heavy charges of dynamite in the supporting columns produced no effect. Oxy-acetylene torches were then employed to cut off the steel rails that reinforced them, the weight being shifted to wood shores. Even the effect of the heat and flames of burning kerosene-soaked shores, roaring up through the barrels of the tanks, apparently had no disintegrating effect, as the structure was not wrecked when it dropped on edge. Wrecking cranes finished the work, starting at the top and pulling the tanks apart in chunks.

SUBJECT TO STEEL MILL GASES

The structure was the stock house of the Universal Portland Cement Company, located on the premises of the Illinois Steel Company. There were four cylindrical tanks and an interspace bin on centers 26 ft. apart at a clear height of 12 ft. above the 3-ft. foundation slab. The tanks were 53½ ft. high, measured to the eaves of the roof, which was 70 ft. above the ground level. The tank walls were 7 in. thick, half way up, and 5 in. the remainder of the distance. The group was designed and built by E. Lee Heidenreich, and was the first of the kind built in America.

The wall reinforcement consisted of 1 x 4-in. mesh galvanized Clinton electrically welded wire with the larger percentage of wire vertical in the center of the walls. Alternately, inside and outside, spaced on 4-in. centers, were horizontal round rods ranging from 1 in. in diameter at the bottom to ⅜ in. at the top. These rods were hooked together at the ends.



WRECKING 15-YEAR-OLD BINS PROVED A SLOW JOB

The conical tank roofs were 2 in. thick, of 1:3½ mortar, and were reinforced with wire fabric, radial and circumferential rods. The thrust of the roof was taken by a 5-in., 13.9-lb. Z-bar band under the eaves. The conical bottom was built with the top of the cone upward and the outlets around the circumference. The bottom was 4 in. thick, reinforced in the same manner at the top.

Each tank was supported by eight struts, those struts on the center lines and diagonal lines between bins being approximately 1 ft. 10 in. x 7 ft. 10 in., and those at other points 1 ft. 10 in. x 3 ft. 5 in. in plan. They were of 1:3:4 concrete, in which were imbedded eight and four 70-lb. steel rails respectively. These rails were banded together and butted against a ½-in. steel plate at top and bottom.

TWELVE-FOOT FALL DAMAGES TOP COURSE

BOTTOM INCLOSED BY CURTAIN WALL

The lower part of the structure was inclosed with a 1-in. curtain wall reinforced with 1 x 4-in. wire fabric. The elevator boot and head house were of steel construction and supported Monier siding reinforced-concrete plates 2 x 5 ft. x ⅝ in. thick. These plates resemble sheet piling in shape, the flange overlapping the steel angle section and top of the plate below.

The foundation of the structure was a flat slab 66 ft. square, reinforced with a grillage of steel rods. This foundation, which was one of the first flat-slab construction in this country, was built upon slag fill.

DYNAMITING THE COLUMNS OF NO AVAIL

The original plan was to tip the building over toward west, hoping that it would collapse when falling. Eight holes were drilled in each of the columns, except those on the east side of the building, and loaded with ½ lb. of dynamite to the hole. These loads, however, failed to cause the collapse of the columns. The reinforcing rails were then cut with an oxy-acetylene flame. Before each column was wrecked timber shores were set up to carry the load temporarily.

This done, the wreckers expected that when the columns on the west side were removed the bins would fall. To knock them out a preliminary blast of about 30 lb. of dynamite was fired which did practically no damage. Then 60 lb. was set in, and braces were placed between several shores and the columns that were to be blasted, so that the shores would be knocked out by the explosion. The blast was terrific, but the bins did not fall; in fact, no damage was done to them and the shores were not knocked out.

BURNING THE SHORES DROPPED ONE SIDE ONLY

The next step was to shore around the remaining west columns. Firewood was piled up around all shores and in the interior.

Before resorting to the fire it was necessary to finish the wrecking of the west column, so a crane was brought up and cables were attached to the cut rail sections, which were pulled out, thus leaving the east side columns and the shores holding the tanks. Kerosene was then dashed on the wood and the fire was lighted. It burned for at least 45 min. before the bins fell. The west side dropped 12 ft. to the concrete foundation and the columns under the east side buckled backwards, permitting that side to settle about 3 ft. The bins settled at an angle of about 20 deg. from the vertical and became stable at this position. When they fell the head house was snapped forward, falling through the southwest tank roof, and carrying it with it. A close inspection of the east and north sides showed that the tanks were set upon the base beams and columns without any reinforcement bond. These columns and beams were destroyed when the bins fell. One column remained upright, the bin having slid from it, thus permitting it to puncture the hopper bottom.

60 LB. OF DYNAMITE LEFT TANK STILL STANDING

At this stage the wreckers were but little nearer the completion of their task than at the start and it was evident that some other procedure must be followed.

WRECKING CRANE PULLS TANKS APART

The next and last scheme was to destroy the tanks in small sections starting at the top, so three cranes were rigged for pulling them apart in chunks. The cranes, rigged with 1-in cables, hitched on to the wreck of the head house and pulled, but the cables broke and were replaced with 1½-in. cables. The head house was finally pulled down after one crane was wrecked. With it came part of the roof and the top courses of the west bins. Several broken ends remained. To these the cables were attached and by strenuous pulling the courses formed by successive days' work were torn away. As fast as the concrete was pulled down it was lowered into freight cars and carried away. The structure yielded more readily to this method of attack because the only vertical reinforcement was the wire fabric, and many instances evidenced the fact that little care had been exercised by the builders in securing a good bond between successive days' work. Close examination indicated the excellent conditions of the reinforcing steel.

TANKS SETTLED BACKWARD ON REAR COLUMNS WHEN THEY FELL

EVEN FIRE DID NOT AID IN DESTRUCTION

CONCLUSIONS OF AN OBSERVER

The wrecking of this structure afforded in excellent opportunity of studying the strength of concrete structures and the degree of protection afforded the steel reinforcing by the concrete in which it was imbedded. The conclusion reached by J. W. Lowell, observer for the cement company, brought out these points:

The strength of the structure was no less than marvelous when it is recalled that a shell but 5 and 7 in. thick and 55 ft. high, weighing 2,000,000 lb., fell a distance of 12 ft., landing at an angle and on one edge, was apparently not damaged in the least. This occurred after several hundred pounds of dynamite had been shot in its foundations and supports, each of which caused a sufficient disturbance to rock the structure and which would have demolished an ordinarily constructed building. There was one other extreme condition effective at the same time, and that was the extremely hot fire which roared up through the bins as through a chimney, causing severe stresses due to a very rapid change of probably 300 deg. Fahr. of temperature in less than 45 min.

The reinforced-concrete had been in service for fifteen years under severe conditions of exposure, not only because there was no protection from atmospheric conditions, but also because the structure stood on the lake shore and was located on the premises of a large steel mill, which continually liberates large volumes of gases known to attack steel.

BARS, RAILS AND MESH INTACT AFTER FIFTEEN YEARS

The steel reinforcement was protected by various thicknesses of concrete and cement mortar. The steel rods and mesh in the tank walls were covered with from 2 to 3½ in. of cement mortar. The mesh, which was galvanized, and the rods, which were not, were equally well preserved. There was rust on the rods in places, but the concrete surrounding such spots was not discolored—a point considered sufficient indication that the rust was on the rods before they were embedded. The rails in the pilasters were exactly as they had come from the rail mills, clean and blue, with a thin white film of cement over them. In several places the steel scale on the rails came off with the concrete when it was broken away.

WALLS AND FLOOR BROKE IN LARGE PIECES

The curtain wall surrounding the lower part of the structure was built up of cement mortar with a reinforcing of galvanized wire mesh embedded from ¼ to ½ in. from the outside face. Wherever this embedment was complete there was no sign of rust or disintegration, and this condition was practically uniform throughout.

The most remarkable example of protection offered by the concrete was in the case of the Monier siding plates, which were only ⅝ in. thick and in which the wire fabric in many cases was found to be embedded from ⅛ to ¼ in. This steel was fairly well preserved. There were, however, numerous places where the wire was seriously rusted, indicating that this amount of embedment was not sufficient to give permanent or complete protection. It was noticed that at several places where there were open cracks, both the steel wire and rods had been acted upon and heavily coated with rust. At such places the sides of the cracks were blackened by the atmospheric conditions and the concrete surrounding the steel was discolored by the rust. Several small places where such conditions prevailed were noticed where a complete bond had not been obtained between consecutive courses of concrete. These spots were small, and even though the reinforcement might eventually become damaged at such places, the effect on the structure in general would be negligible.

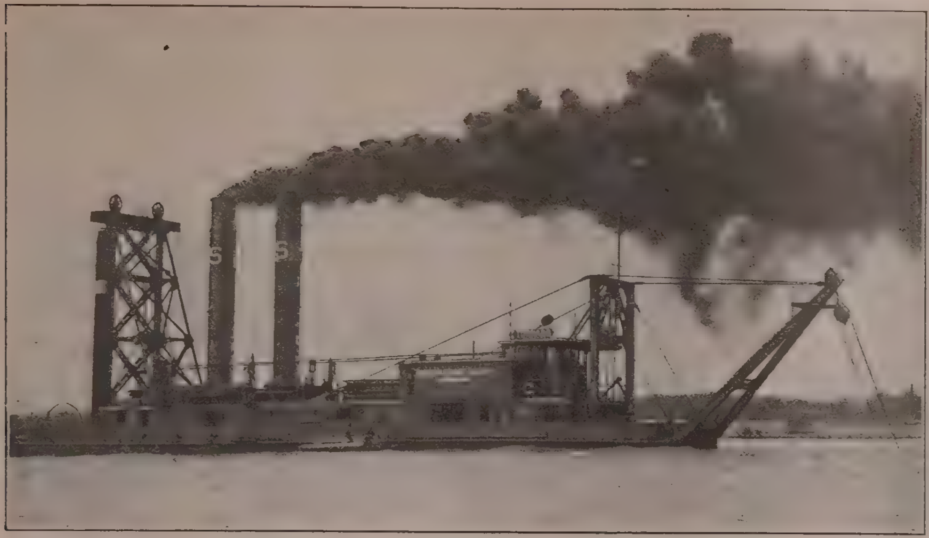
Freight Traffic at Sault Ste. Marie Shows Marked Increase

The total freight traffic at Sault Ste. Marie of 71,290,304 tons for the season of 1915, when compared to that of 1914, shows an increase of 29 per cent, or 15,920,370 tons, according to statistics compiled in the U. S. Canal office at Sault Ste. Marie under the supervision of L. C. Sabin, general superintendent. Individual items showing an increase were wheat, copper, iron ore, lumber and general merchandise.

The passages through both the American and Canadian canals numbered 21,233, an increase of 13 per cent.

The season of navigation continued for a period of about 8¼ months, during which time the average monthly freight traffic was 8,626,827 tons.

The traffic through the American canal was 89 per cent of the total freight, 85 per cent of the total net registered tonnage and 50 per cent of the total passengers.



THIS DREDGE HAS PUMPED AS MUCH AS 1650 YARDS, PLACE MEASUREMENT, IN AN HOUR ON THE TORONTO HARBOR IMPROVEMENT WORK

Large Suction Dredges Depend on High Velocity for Extraordinary Output

Discharges of 38,500 Cu. Yd. Recorded for One Dredge on Toronto Harbor Improvements, Involving 32 Million Yards of Fill

TWO 1700-ton dredge boats are pumping from 12,000 to 38,500 cu. yd. of material apiece daily from the lake and harbor bottom of Toronto to make the 32,000,000-yd. fill required for the harbor improvements now being carried out by that city. In point of capacity, if not of displacement, they are thought to be the largest single dredging units ever operated or built. Though no precedent existed for their design, so successfully was this worked out that the Cyclone, the first one commissioned, ran three weeks without stop from the time steam was first raised in her boilers, and handled in that time half a million yards of material. These dredges depend for their tremendous output and their success in handling heavy material and small boulders on high velocity of flow rather than on large-sized suction and discharge lines. Their main centrifugal pumps, with a shaft speed of from 210 to 225 r.p.m., impart a velocity of from 15 to 18 ft. per second to the stream as it leaves the fan casing, maintaining a pressure of 85 lb. per square inch on the discharge line and a vacuum of from 22 to 25 in. on the suction line. Though both lines are but 2 ft. in diameter, an output of 1650 cu. yd. per engine hour has been recorded, and both dredges can maintain an average output of from 1000 to 1200 cu. yd. per engine hour in all material. This efficiency is attained largely through the greater transporting power of the high-velocity stream, which enables the pump to handle a much higher per cent of solids than is usual.

EXTENDED PORT IMPROVEMENT

The comprehensive harbor improvements being carried out at Toronto were described in the Engineering Record of Sept. 19, 1914, page 326, and the general plan published at that time is reproduced herewith. The dredging work so far done has been at the mouth of the Humber River and in Humber Bay, filling the upper curve of the shore at this point; in the eastern channel and at its inner end, and in the channel from the harbor to the turning basin.

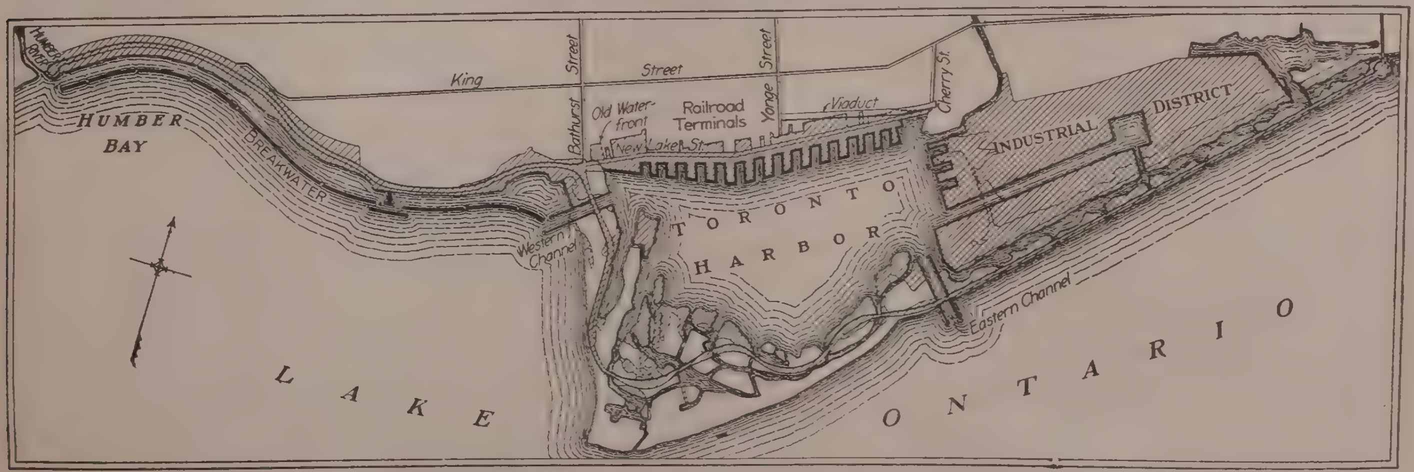
The material dredged at the mouth of the Humber River consisted of gravel and boulders up to a foot in diameter, with which was mixed much peat, some clay and a large quantity of crib work and driftwood. This last clogged the cutter head of the Tornado, which has done all of the dredging at this point, and caused frequent delays to raise the latter so that the timbers could be removed. It was here that the low record of 12,000 yd. for one day's output was made. The other dredge, the Cyclone, and also lately the Tornado, has been digging the more favorable material, largely coarse sand, which makes up the bulk of the dredging. In this much higher average outputs have been maintained.

FEW BENDS IN PIPE LINES

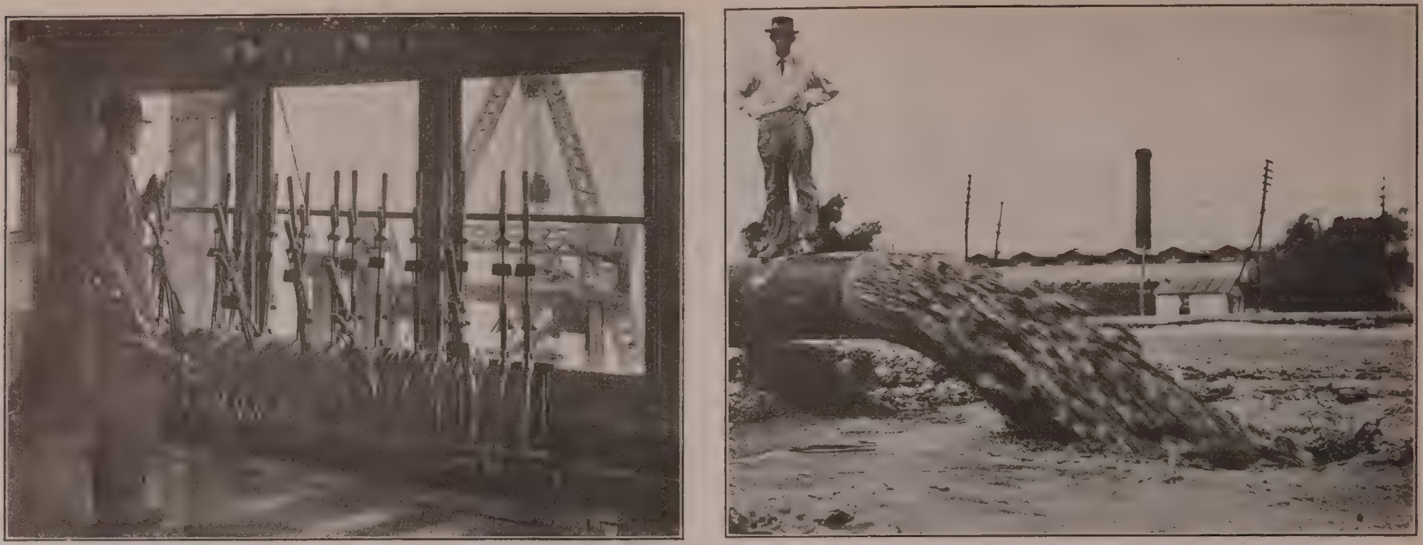
These dredges are designed with a ball joint in the suction line at the top of the ladder, and with a long-radius bend in the discharge connecting the pump to a line carried under the deck to the stern of the dredge, where it joins the floating discharge line. This reduction of frictional resistance is accomplished by setting the main pump with the axis of its fan chamber at right angles to the long axis of the hull, giving a straight lead in a vertical plane for the suction. The tendency in the design of large dredges has been to use a swing joint with two bends at the top of the ladder, and either to set the pump with its fan chamber parallel to the axis of the hull, requiring another bend in the suction, but giving a straight lead for the discharge, or to set the pump as was done in these dredges, requiring four bends in all in the suction and one in the discharge line. The ball joints used on these dredges have proved perfectly tight and are asserted to have given satisfaction in every way.

The hulls, which are shown in the accompanying drawing, are of structural steel. Transverse girders carry the machinery deck, and, through light longitudinal girders, the bottom plates. Lighter transverse girders above support the main deck. Both sets are carried by two main longitudinal girders, or keelsons, and by the gunwales. These girders have solid webs for most of their length. Between them are located the main pump and auxiliary equipment and the four marine boilers. Outside them are the coal bunkers, trimming tanks and storage space for oil. The bulwarks shown were not, of course, put on the hulls until after all of the machinery had been installed. They enable the dredges to stay out in moderately bad weather, although the boats must seek shelter in heavy storms. They are especially needed because it is the intention to use the boats on the Atlantic coast after the work at Toronto is finished.

The main pumping engine is a triple-ex-

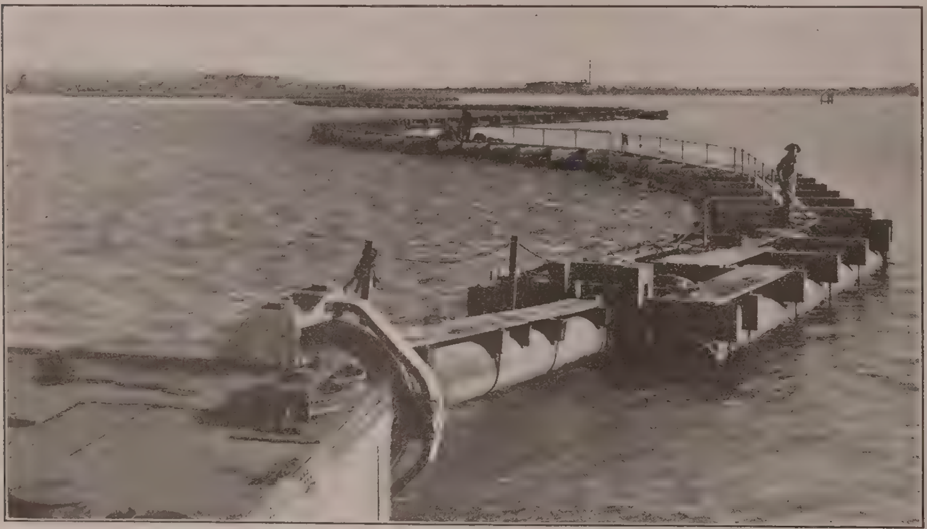


FIRST DREDGING WORK ON 32,000,000-YARD IMPROVEMENT DONE AT MOUTH OF HUMBER, IN HARBOR AND IN CHANNEL TO TURNING BASIN



MAN WHO HANDLES DREDGE KNOWS BY GAGE BOARD AND "FEEL" OF HOISTING LINES WHEN DISCHARGE A MILE AWAY CARRIES RIGHT PER CENT OF SOLID

pansion vertical unit of 1750 h.p., 18¼ x 28 x 46, with 20¼-in. stroke, operating on 200-lb. steam pressure. It is fitted with a separate condenser from that used for the auxiliary equipment, which makes it possible to maintain a vacuum of 28¼ or 28½ at all times, greatly increasing the efficiency of the engine. The main pump casing has an internal diameter of 11 ft. 10 in., and its 5-ton runner has a diameter of 8 ft. 4 in. Assembled, both weigh 45 tons. The pump casing is lined with removable castings except for the outer ring, which is replaced entire when necessary. That on the Cyclone has had 1½ in. of cast steel worn from its 4-in. thickness after pumping almost 4,000,000 yd. during the past season, and will be renewed this winter. The runners do not wear seriously.



BALL-JOINTED DISCHARGE LINES ARE ANCHORED AT INTERVALS TO REDUCE TENSION

A complete set of spare parts is kept on board each dredge, and all the auxiliary equipment, including the 15-kw. lighting units, is installed in duplicate. A crane spans the engine room to handle heavy parts in making repairs. The four boilers have a combined grate area of 300 sq. ft. and a heating surface of 11,000 sq. ft. They have a working pressure of 225 lb. Three of them are sufficient to operate the dredge, and they are used in rotation, each being idle every fourth week. This surplus equipment has saved a great deal of money, as a few weeks' loss of working time for one dredge represents a sum sufficient to pay for the extra installation.

LADDER REACHES 50-FOOT DEPTH

The ladders on these boats meet the unusual requirements of dredging to a 50-ft. depth. This depth was necessary to obtain enough material to make the enormous fill. The ladders are 85 ft. long, contain 85 tons of structural steel and weigh, complete with cutter, shaft and engine, more than 125 tons. They are made up of two outside girders, with cross diaphragms, which are solid for their upper halves and support the suction pipe, which runs through them below the axis of the ladder. The cutter engine is mounted on the inner end of the ladder. The five-blade cutter head, 8 ft. 6 in. across, is operated through a 9-in. diameter shaft at a speed of 15 r.p.m.

The ladder is 11 ft. 6 in. deep and 12 ft. wide at the dredge, and is hinged on cast-steel trunnions 30 in. in diameter on either side at the back of the ladder well. These trunnions are riveted to the hull, and over them fit horseshoe-shaped cast-steel collars, open at the bottom, which are riveted to either side of the ladder. The ladder is thus held in place only by its own weight, and it is consequently easy to ship and unship. Rubbing strips at the forward end of the ladder well, 16 ft. from the center of the trunnions, correspond with inclined stiffener angles on the ladder, and keep the hull and ladder in vertical alignment.

78-FOOT SPUDS

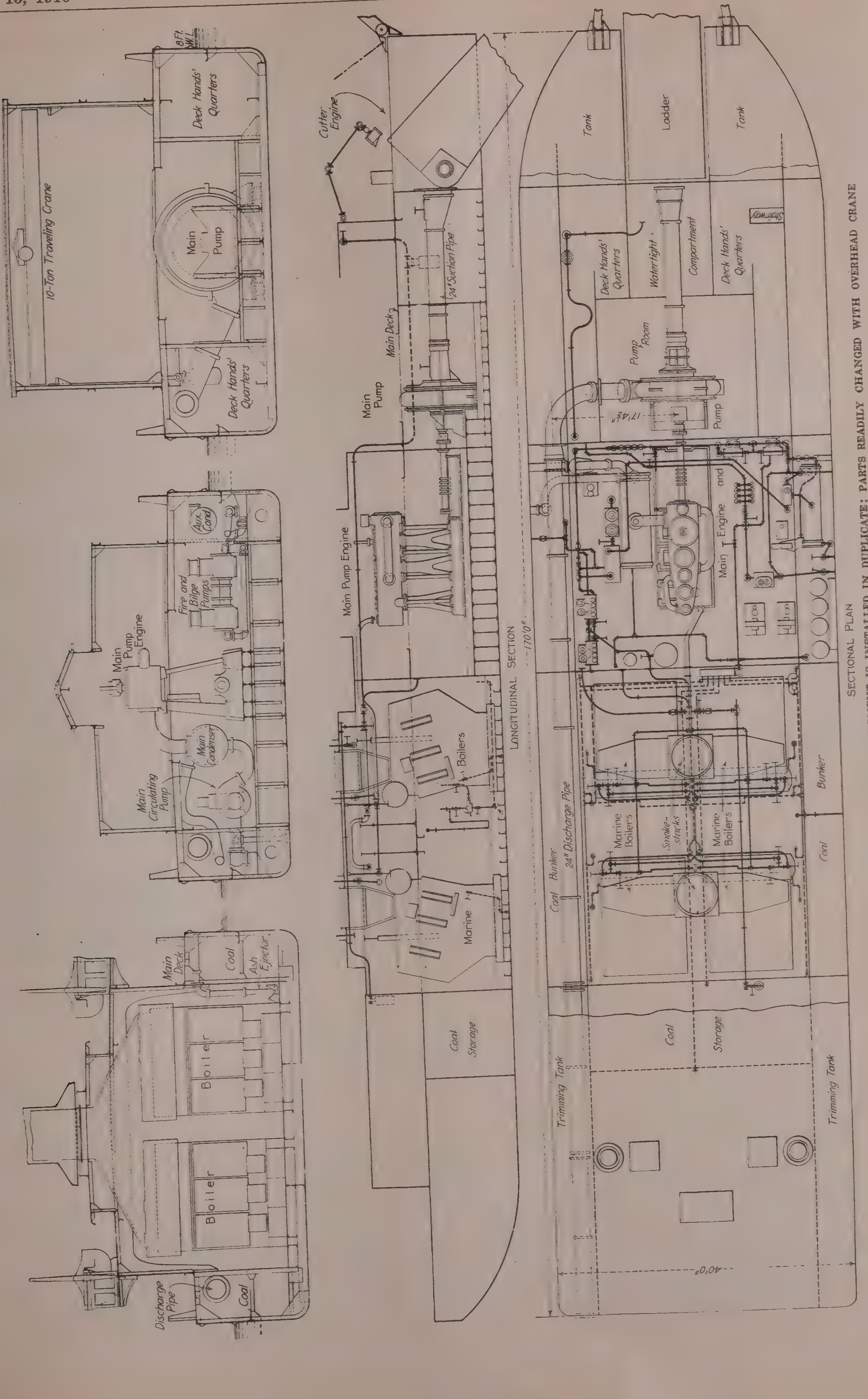
The spud frame, shown on the rear of the boat, supports two 78-ft. spuds. Each is made of a single stick of fir 42 in. in diameter, shod with a 10-ton cast point. The two spud engines have 42-in. drums, and the spuds are each handled on a single 1⅜-in. line. As with all the sheaves on these dredges, those on the spud frames are of very large diameter. It is pointed out that the saving in wire rope through having sheaves of the proper size on a big dredge, where many thousand feet are in constant service, is very appreciable.

On these spud engines, as on all the rest of the machinery, all castings are of steel. The only wood on the boats is in some of the fittings of the operating cabs. The main floors are of cement and composition rubber, and everything has been detailed so that it is easy to keep the boats as clean as the best installed permanent power plants. This not only prolongs the life of the boats, but is said to exert a distinct influence on the class of men it is possible to hold, and on their attitude toward the work.

PIPE LINES EASILY MOVED

The floating part of the discharge lines is made up of 60 and 90-ft. lengths of lap-welded pipe of ½-in. metal, mounted on steel pontoons, and connected with pressure-tight cast-steel ball joints. The line was designed and its units were built at the site by the contractor. In use it trails behind the dredge with a little slack, being anchored at intervals to prevent winds or currents from laying hold of a sufficient length of it to subject it to undue stress.

The land pipe line is thought to be a distinct advance over anything used heretofore. It comes in 12-ft. lengths, each readily handled by four men. One end of each length is flared 1 in. for a distance of 1 ft. A pressure-tight joint is made in a few seconds by driving a plain end into a funnel end with a light timber ram. In spite of the skepticism of the dredge captains, these joints did not part under pressure. The secret of their success is said to lie in the selection of the proper thick-



MAIN PUMP LINES HAVE BUT TWO BENDS AND AUXILIARY EQUIPMENT IS INSTALLED IN DUPLICATE; PARTS READILY CHANGED WITH OVERHEAD CRANE ness of metal, which, for a 2-ft. line, is ¼ in. Each line, after it reaches the shore, forks with a two-way valve, so that one discharge can be shifted at a time without shutting down the dredge.

ONE MAN CONTROLS OPERATION

The dredges are operated on the familiar principle of swinging them by side lines around first one spud and then the other. The two side lines pass through sheaves near the outer end of the ladder. They are fastened to anchors which are set a considerable distance ahead of the dredge on either side, and thus do not have to be moved during the day's run. The dredges swing through an arc whose chord is from 225 to 250 ft. The limit of depth for a single cut has not been reached, though 20 to 25-ft. cuts are being made in one operation.

The twenty-one levers controlling the throttles, brakes and frictions of the spud hoists, and the swinging, anchor and ladder hoists, are banked in the operating cab at the forward end of the deck house, and are handled by one man. Before this man are gages showing the vacuum in the suction and the pressure in the discharge line. These tell him as he swings the dredge whether the material is coming too fast or too slow. The "feel" of the tension on the swing lines also gives him a good idea of whether or not he is cutting into the bank too fast.

Each dredge is in charge of a captain with a chief engineer, two assistants, an oiler, a leverman, five firemen and six deck hands for each shift. All of the deck hands are sometimes needed to take care of the floating pipe line. When not so employed, they are loading and passing coal.

All of the men are required to live ashore. A galley is provided and food kept on hand for overtime workers.

The land ends of the pipe lines for each dredge are handled by a foreman and six or seven men. Two powerful electric searchlights with an effective radius of 2700 yd. are mounted on each dredge to illuminate any section of the pipe line which requires attention at night.

The Toronto harbor improvement is being carried out for the Toronto harbor commissioners under the direction of E. L. Cousins, chief engineer, and J. R. Wainwright, assistant chief engineer, by the Canadian Stewart Company, Ltd. C. F. Franson, vice-president of the Stewart Company, has the general direction of the work and designed all of the dredging and other floating equipment.

Cracks in Sioux City's Pavements

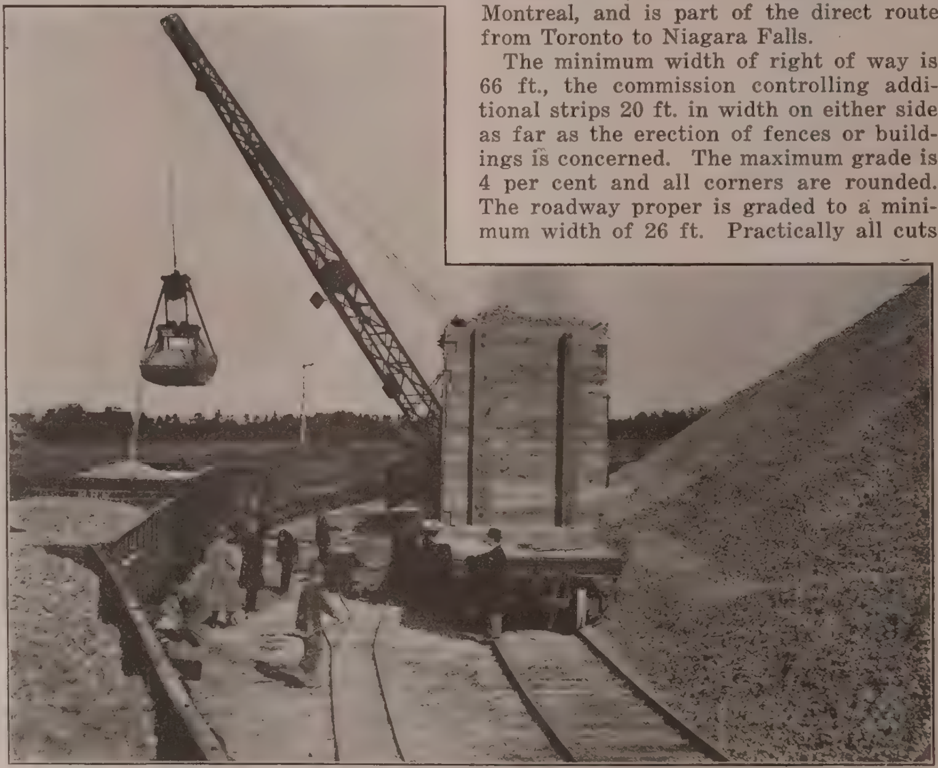
In the Engineering Record of March 4 there appeared an article entitled "No Cracks in Sioux City's Concrete Pavements," giving an abstract of a discussion read by the city engineer of Sioux City, T. H. Johnson, before the Second National Conference on Concrete Road Building. The opening sentence conveyed the same idea as the title, in these words: "Not a single cracked section has developed in Sioux City's 1,000,000 sq. yd. of concrete pavement, some of which has been in service 5 years." Mr. Johnson calls the attention of the Engineering Record to the fact that this goes beyond the statement he made. He did not state that there were no cracks in any of the Sioux City pavements, but that there were "continuous miles of it without a single cracked section."

36-Mile Concrete Road, Built by Day Labor, Will Link Canadian Cities

In Toronto-Hamilton Highway Construction Special Methods Were Developed for Handling Concrete Materials—50-Foot Finishing Bridge a Feature

By H. S. VAN SCOYOC
Chief Engineer, Toronto and Hamilton Highway Commission

THE Toronto and Hamilton Highway Commission is joining the two largest cities in Ontario with a 36-mile concrete roadway that will be longer than any other continuous stretch of concrete 18 ft. in width yet completed. The project is being carried through at this time because of industrial conditions that were created at the beginning of the great war in which Canada, as a part of the British Empire, is engaged. In August, 1914, unemployment was a serious problem, more particularly in the larger centers of population. It was felt that the approaching winter would cause much suffering if some form of relief work was not undertaken. Highway construction was suggested as a suitable field, and the Toronto to Hamilton roadway was proposed as the most promising one because many of the municipalities interested in its construction had already expressed a desire to have the work undertaken.



CONCRETE AGGREGATES UNLOADED BY LOCOMOTIVE CRANES AND CLAMSHELLS

CONSTRUCTION BY DAY LABOR

A commisison was appointed Sept. 17, 1914, and was successful in having suitable resolutions passed by the interested municipalities during the succeeding month. Actual construction was begun early in November. It was felt that day labor offered the only satisfactory method of providing work for those in greatest need. So many deserving men sought employment on this work that it was necessary to make frequent changes in the gangs. Work was continued during the winter where the grading was the heaviest. The problem of the unemployed became less acute as summer progressed, and at the present time it is the lack of laborers, rather than lack of work, that is serious.

The highway, in general, follows established road allowances, although in some instances diversions have been made to correct alignment or shorten distances. The route chosen skirts the shores of Lake Ontario, passing through one of the most intensely cultivated sections of the Province. The scenic beauty should prove a strong attraction to tourists. It forms what is possibly the most important link in the highway that will eventually join Windsor, Ont., opposite Detroit, Mich., with Montreal, and is part of the direct route from Toronto to Niagara Falls.

The minimum width of right of way is 66 ft., the commission controlling additional strips 20 ft. in width on either side as far as the erection of fences or buildings is concerned. The maximum grade is 4 per cent and all corners are rounded. The roadway proper is graded to a minimum width of 26 ft. Practically all cuts have been taken out to a width of 40 ft. and a width greater than 26 ft., provided on the heavier fills. All structures have been extended or replaced with the exception of bridges spanning four rivers, and it is anticipated that these bridges will be replaced in the near future, as they are not satisfactory for present traffic conditions. The minimum clear width on bridges and culverts constructed or reconstructed is 26 ft. They have been built of plain or reinforced concrete. Reinforced concrete pipe has been used under farm approaches and for the pipe culverts under the roadway proper.

The concrete paving is 18 ft. wide, 6 in. thick at the edges, and 8¼ in. at the center. The crown is parabolic and the subgrade level. The specifications are practically those of the American Concrete Institute, except that the proportions used are 1:1½:3. Cement fine aggregate and coarse aggregate have been carefully inspected. The cement has come from one store-house and was thoroughly sampled before shipments were begun. Additional tests have been made from time to time. The sand has been tested at the pits before being shipped, both as to grading and loam content, and all broken stone has been inspected at the quarry. Test cubes have been made up from the concrete as it has gone into the roadway. They have been subjected to the same curing processes as the roadway itself.

ORGANIZATION AND EXTENT OF WORK

Under the chief engineer the principal heads have been a division engineer and a superintendent of construction. The road has been divided into four sections each with a resident engineer reporting to the division engineer, and a general foreman reporting to the superintendent of construction. From the city limits of Toronto to the city limits of Hamilton the distance is approximately 36 miles, but up to the present time construction has been limited to the 31 miles nearest Hamilton.

FOR LOADING INDUSTRIAL CARS WITH SAND AND STONE PORTABLE WOODEN BINS WERE USED

WHERE PAVING WAS 50 FEET WIDE TWO MIXERS WERE USED TO HASTEN CONSTRUCTION

In addition to this main highway the scheme includes a secondary road 7200 ft. long on which the concrete is 9 ft. in width. A portion of the main highway in the town of Oakville has been paved with concrete to a width of 50 ft. in the business section and 30 ft. in the residential section.

It was planned originally to distribute the materials from three yards which would have divided the distances equally and given an average haul of a little more than three miles. Delays made more distributing points desirable, however, and five sidings have been used.

EQUIPMENT

In the larger yards the unloading has been done by locomtive cranes and clamshell buckets. At the other points it has been by hand. Practically all of the materials have been hauled by an industrial railway outfit, consisting of three 7½-ton steam locomotives, 110 V-shaped dump cars, each holding 1¼ cu. yd., and about 15½ miles of 24-in. gage sectional track.

The concrete for the roadway has been mixed in five ½-yd. and one 1/3-yd. cube pavers with booms and overturning buckets. Water has been taken from the lake through 2-in. pipes by five triplex pumps driven by 8-hp. gasoline engines. The grading outfit consisted of five rollers, one gasoline tractor, two scarifiers, graders, pick ploughs, rooters, slushers, wheelers, etc.

SPECIAL CONSTRUCTION METHODS

For loading the small cars with sand and stone a special device was used that differs in some respects from those ordinarily employed. Wooden bins having a capacity in excess of one train-load as hauled on the industrial railway, were built on standard gage flat cars of 100,000 lb. capacity. Two were provided for each crane, one for sand and one for stone. Each had two chutes so spaced that two small cars could be loaded at one time, one laborer being able to manipulate both chutes. By this plan two cars were loaded in less than half the time required for loading one car direct from the bucket.

It is possible to avoid practically all waste in loading in the yard. The cars can be loaded evenly so that the material is properly distributed on the sub-grade, preventing not only waste but the necessity for handling excess material or the possible delay due to a shortage in delivery. It was possible to spot the bins rather than the cars, which permitted the locomotive to do other work. A train can be loaded without the crane. This is especially advantageous when an extra trip is made, as it is not necessary for the crane runner to work overtime. The plan is of greatest benefit when the number of small cars is limited and the haul short, as the delay in the yard is reduced to a minimum.

50-FOOT FINISHING BRIDGE

Where the paving was 50 ft. in width a special bridge was constructed. Four 6-in. I-beams were taken from one of the discarded steel bridges and so clamped that the I-beams were free to move in or out. The ends rested on steel rails which were kept well greased, the bridge being easily moved with pinch bars. It was a very satisfactory solution to a rather perplexing problem, as it supported four floaters at no great height above the surface of the pavement.

Where the paving was 50 ft. in width two ½-yd. mixers were worked side by side. The plan was of advantage in that a greater yardage was laid daily than would have been possible with only one machine which would have reduced the length of time that traffic was forbidden in the business section. It was not economical, however, as far as the labor cost per square yard of paving was concerned.

Instead of depending upon a strike-board for the proper crown, rows of stakes were set across the street at intervals of 6 ft. Two rows were driven with each move of the mixers, as it was found impracticable to set them in advance. This meant quite a loss in mixing time on account of the large gang employed. It would have been more economical under these conditions to have laid the concrete with one mixer working in the center of the street, as the decrease in time lost would have more than paid for the extra cost of distributing the concrete.

It is hoped at the present time to have construction work completed in the early fall.

The division engineer of the Toronto-Hamilton highway is Charles Johnston and the superintendent of construction R. T. Bell. The commission consists of George H. Gooderham, chairman; G. Frank Beer, honorary secretary; Ruben H. Lush, W. S. Davis, M. C. Smith, Hugh Bertram and Controller T. W. Jutten.

Pennsylvania Railroad Employees' Records for 1915 Are Exceptionally Good

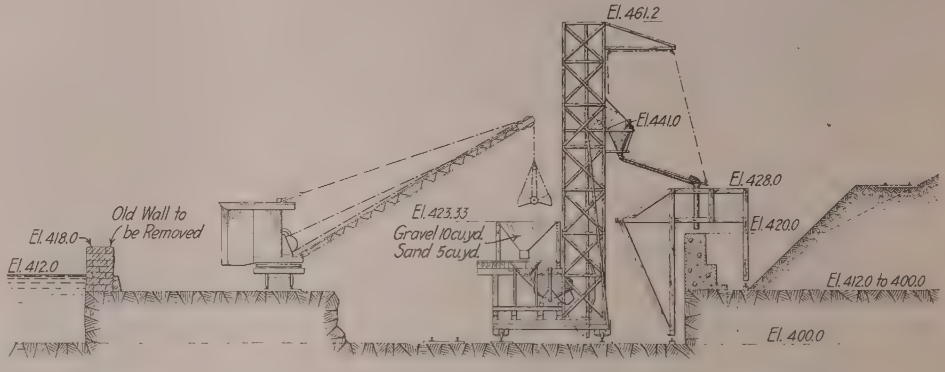
In four classes of tests, including obedience to stop signals, not a single failure on the part of any employee of the Pennsylvania Railroad Lines East of Pittsburgh occurred in 1915, the third year in which no passenger has been killed in a train accident on this road. A total of 4,364,519 tests and observations were made to determine how well the train-operating rules were being obeyed and the results show that only one error occurred in 1110 trials, giving a record of 99.9 per cent of absolute perfection. An exceptionally high record was made in the observance of rules intended for the safety and protection of the employees themselves. Accidents to employees were reduced 11 per cent. Only eight failures to follow strictly the rules governing watchmen stationed at grade crossings occurred in 62,934 trials.

PORTABLE CONCRETE PLANT BUILT LOUISVILLE CANAL WALL

Portable Concrete Plant Builds Louisville and Portland Canal Wall

Rock Drilling Experience, Dynamite Trials and Excavation Layout Plans Features in Canal Widening Construction

A PORTABLE concrete plant, fed by a locomotive crane delivering aggregate from the barges paralleling the work into the mixer storage bins, was employed in placing the concrete for the new wall of the widened Louisville and Portland Canal built around the Falls of the Ohio at Louisville, Ky. The work of widening the canal from 90 to 200 ft., construction of new locks, reconstructing the dam to provide a 9-ft. low-water stage and cleaning the basin at the head of the canal, is part of the improvement of the Ohio River from Pittsburgh to Cairo, approved by Congress in 1910. The first items are under contract and the second was described in the Engineering Record of June 26, 1915, page 794. The third and fourth items have been constructed. Work on the widening of the canal began May, 1913, and will be completed by June, 1916, as it was 90 per cent finished March 1.



LOCOMOTIVE CRANES LIFTING AGGREGATE FROM CANAL BOATS TO CONCRETE PLANT

EXTENT OF NEW WORK

The canal is to be widened from Fifteenth Street to Twenty-sixth Street, the old canal filled and an emergency dam of the Boulé type constructed above the locks. The dam is to be closed in case of accident to the locks. The contract calls for excavating the canal to a width of 200 ft.; constructing a new concrete canal wall and removing the old masonry; constructing a concrete pier for the new bridge over the canal at Eighteenth Street (see the Engineering Record of Aug. 14, 1915, page 199); building concrete foundations for the section of the emergency dam between the old and the new north canal walls; extending the drydock culvert and drainage culverts, and building a retaining wall across the old locks below the guard gates.

Some of the quantities are 770,000 cu. yd. of earth excavation, 205,000 cu. yd. of rock excavation, 550 lin. ft. of drilled bolt holes, 490 cu. yd. of reinforced concrete, 16,951 cu. yd. of plain concrete and 48,300 sq. ft. of channeling; all to be completed in three years.

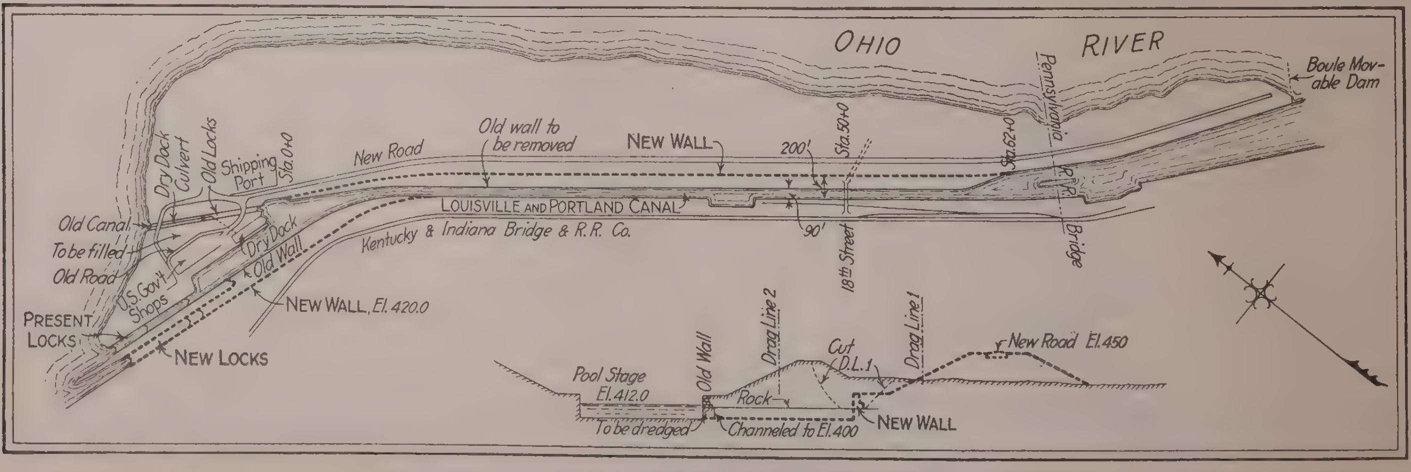
In developing a working plan a contour map on a scale of 40 ft. to the inch was made, and each scheme proposed was studied with the aid of blue line prints of this plan. This investigation quickly showed the advantages and disadvantages of each scheme and aided materially in the selection of equipment. The working plan was for dragline 1 to start at Sta. 59 and work west, making the embankment; dragline 2 was to follow, loading all the surplus on cars, to be disposed of in the new levee from Sta. 59 to 80 and in filling in the old canal. Owing to delays in the erection of the draglines, No. 1 was helped out from Sta. 50 west by Thew shovels and teams, and the Marion shovel loaded some of the surplus east of Sta. 50.

The levee from Sta. 59 east was made from a trestle, the rise from the loading track to the trestle being made on a 3-per-cent grade, easily ascended with four loads. The fill in the old canal was made from a trestle on one side and from the old roadway on the other.

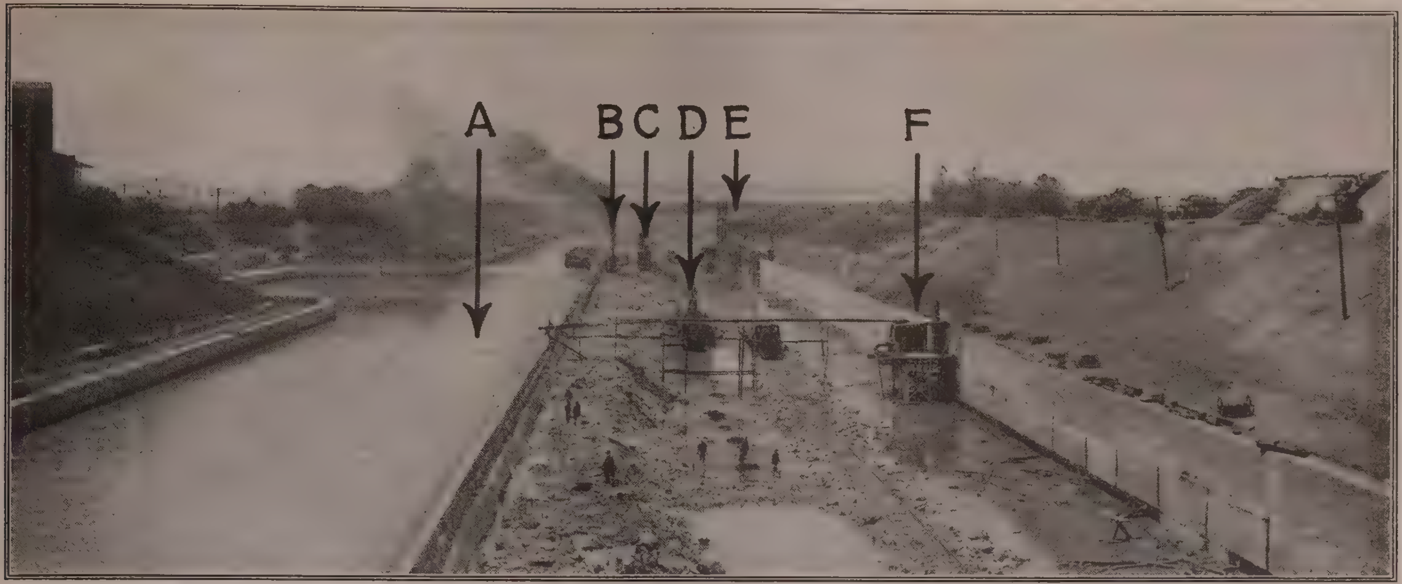
About 15 ft. of earth was left behind the old wall as a cofferdam, but later was removed, as it was found to contain a great deal of rock and was of little value as a dam. A prism also was left behind the new wall to serve as a backfill. After the completion of the new wall this material was pulled down by teams with slip scrapers. The embankment was left 15 per cent high to allow for shrinkage—an amount found to be close to the actual shrinkage when the banks were finally shaped eighteen months later. The slopes were planted with Bermuda grass by the government forces.

ROCK HARD ON DRILLS

The rock work followed behind dragline 2. The ledge consisted of 5 ft. of hard



THE LOUISVILLE AND PORTLAND CANAL IS BEING WIDENED TO 200 FEET



THE NEW LOUISVILLE AND PORTLAND CANAL WILL BE 200 FT. WIDE

From left to right: (a) Old canal. (b) Channeler cutting down rock behind wall to be removed. (c) Locomotive crane feeding. (e) Concrete plant building the new wall. (f) Electric-driven pumping station. (d) Steam shovel loading rock.

limestone over cement rock, which was slightly softer. The rock was difficult to drill and channel, and did not shoot well for shovel work. In chaneling a five-piece drill of 1-in. steel was tried, but found to be worthless. A change was made to a three-piece bit of $1\frac{1}{8}$-in. steel, and even with this bit the steel was often broken and bent.

The first work was done with the wagon drill, but the smallest hole that could be drilled was too large to allow a proper distribution of the dynamite. Tripod drills with $3\frac{5}{8}$-in. cylinders were substituted; they used hollow steels, through which live steam was forced to muck out the holes. The tripod drills made a hole of $1\frac{5}{8}$ in. at the bottom and gave a much better distribution to the dynamite. Steam was furnished by a 60-hp. horizontal boiler and a 40-hp. vertical boiler mounted on a flat car. This car was kept close to the drills so that the steam loss was small. There was practicaly no time lost due to moving the boilers, and the drills could be reset in 7 min.

→ DRAGLINE REMOVING STRIP BETWEEN COFFERDAM AND CUT NO. 1

← MOUNTED BOILERS FED THE FIVE TRIPOD STEAM DRILLS

Try Various Hole Spacings

Different spacing of holes was tried, but the best distribution was found to be 7-ft. squares with a hole in the center of the square. All holes were drilled 18 in. below grade, but at times even this depth did not pull the bottom ledge. Between these steam drill holes smaller holes were drilled with air through the limestone ledge to break this ledge and save block holing. The large holes were loaded at the bottom and at the bottom of the limestone ledge, and the small ones were single loaded.

Different strengths of dynamite from 40 to 75 per cent were tried, but it was found that the best results were obtained with the 75 per cent. An average of 0.4 lb. per cubic yard, pit measurement, was required.

The rock was handled by a Marion shovel and disposed of in the levee from station 80 to 84, in riprapping the river slope from Sta. 70 to 80 and in the roadway from Sta. 50 west. The surplus was used in filling the old canal.

Before filling the old canal it was necessary to extend the discharge culvert for the drydock to the river, from a point where it entered the old canal, a distance of 600 ft. The culvert required a cut of 20 ft. through mud deposited from the river. It was a box of reinforced concrete 4 ft. wide by 6 ft. high, resting on the ledge or on piers founded upon the ledge. The cut was very wet, and steel sheet piling was used for a cofferdam at the river and for the ditch some 200 ft. back from the river. The remainder was sheeted with wood.

Old Wall Serves as Cofferdam

As stated above, it was first intended to leave 15 ft. of earth behind the old canal wall to serve as a cofferdam, but this scheme was abandoned. The first 1000 ft. of wall exposed was backed by a thin slab of concrete to stop the leakage, but the concrete was not found to be very effective and required considerable calking. The remainder was left open and wooden wedges were driven in the weep holes from the back of the wall. The small leaks were stopped by means of a mixture of sawdust, cinders and manure placed on the outside in wooden boxes nailed on long rods. (See the Engineering Record, June 19, 1915, page 785.) These boxes had holes in the bottom and the suction of the water carried the material into the holes and stopped the leaks. The method proved very effective.

Before blasting the last cut next to the old wall the ledge was channeled back of this wall, leaving a strip of from 8 to 12 ft. under the wall to be dredged out. The first section to be dredged extended from Sta. 62 to Sta. 27. At Sta. 27 a cross dam was placed between the old and new walls. It consisted of Lackawanna steel sheet piling tied together with rods and filled with sand and gravel. The material was placed in lifts of about 12 in. and made an effective puddle. When the dam was first unwatered there was a great deal of leakage, but this was gradually checked, and at the end of a week the dam was practically dry.

The pumping plant consisted of three 12-in. centrifugal pumps direct connected to 50-hp. motors. Ordinarily one of these pumps handled all the water. In addition to the pump the contractor constructed a 24-in. sewer from Sta. 0 to the drydock.

PORTABLE CONCRETE PLANT

The new canal wall is of concrete, 4 ft. wide on top and stepped so that the width is approximately 50 per cent of the height. The wall rests on the ledge, the face being flush with the channel cut. It is doweled to the rock with 1-in. square twisted rods spaced on 3½-ft. centers.

The concrete was deposited in alternate monoliths of 40 ft. The concrete plant, as shown in the sketch, was made from old timbers on hand, and, according to the contractor, proved very efficient. The arrangement is simple and few men were required to operate it. The sand and gravel were taken from barges in the canal by a clamshell bucket of the 20-ton Link Belt locomotive crane and placed in the small storage hoppers. From these the aggregates were dropped into the charging hopper and there measured and the cement added; then they were dropped to the 1¼-yd. Smith mixer, hoisted and spouted to place. The batch used was 4 bags of cement, 11 cu. ft. of sand and 24 cu. ft. of gravel. The plant has a capacity of 50 cu. yd. per hour. Both the mixer and the hoist were motor driven and used approximately 40 kw. per 100 cu. yd. of concrete at 1½ cents per kilowatt. This was found to effect a decided saving over steam.

Three sets of Blaw forms holding 7½ cu. yd. each were used and held in place a minimum of fifty hours. The record run was thirty-five sections of 1400 lin. ft. in thirty-five consecutive working days.

Most of the plant was used on a single 8-hour shift. Dragline 1 was on double shift throughout and the entire plant was on double shift during 1914, but it was found that the greater overhead and pumping charges on the single shift were more than offset by the greater output.

Practically the entire plant was bought new for this contract. A portion of it is as follows: Two Lidgerwood-Crawford dragline excavators with 70-ft. booms and 2-yd. Page buckets; one Ingersoll-Rand and one Sullivan duplex channeler; one Ingersoll-Rand wagon drill and five jackhammer drills; five Sullivan tripod drills; twenty-four 12-yd. Western air dump cars; one spreader car; five Porter standard-gage locomotives; one 20-ton Link Belt locomotive crane; one 3800-lb. Monarch pile hammer; three 12-in. Morris centrifugal pumps driven by 50-hp. motors; seven Nye pumps; one 6-in. Buffalo centrifugal pump; one ⅞-yd. Thew shovel; one 1⅛-yd. traction steam shovel, and one Marion steam shovel with 2½-yd. dipper.

The government work at Louisville is under the direction of Major J. C. Oakes, Corps of Engineers, U. S. Army. F. I. Louckes is assistant engineer and R. E. Strecker is junior engineer.

The contractor was the Henry Bickel Company, Louisville, Ky. A. G. Butler is superintendent and engineer in charge.

The subcontract for dredging the old wall was let to the Western Rivers Company, Point Pleasant, W. Va. Mr. Eppling is in charge for this company.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Railway Construction Methods in Australia

SIR: I notice that you have paid me the compliment of including an abstract of my paper on Railway Construction Methods in Australia in your number of Dec. 4, 1915, and commenting on it.

With much that you say I am in accord, but when writing of construction work "started on the heels of the surveyors," I had no intention of suggesting that the location work suffered in consequence. The instances then in my mind occurred in very easy country, where all location problems were easily threshed out more quickly than the center line could be staked and works set out.

Given the same conditions as to quantity and continuity of the work, and freedom to use materials which prove during progress of works to be most economical when both first cost and maintenance are considered, it seems to me that there should be no material difference in costs whether I should build the railways as manager for the Government, or manager for a first-class contracting firm.

After long experience of contractors, both successful and unsuccessful, I find the unit costs of my work for the Government, when put alongside theirs, are certainly not higher.

MAURICE E. KERNOT,
Chief Engineer for Railway Construction, Victorian Railways.

Should There Be Only One Government Survey Bureau?

SIR: For more than one hundred years the United States Government has been engaged in the extension of public surveys. While public land surveys were undertaken some years before the United States Coast and Geodetic Survey was organized, yet the two branches might be said to have developed simultaneously.

The United States Coast and Geodetic Survey has always enjoyed the confidence and respect of scientific men at home and abroad. It has laid a foundation for a complete triangulation network covering the entire country. It has determined with accuracy the elevation of many stations. It has surveyed our coast line and prepared topographic maps of the contiguous country. It has always enjoyed the aid and co-operation of the army and navy officers except in times of war.

Because the work of the United States Coast and Goedetic Survey demands the services of highly-qualified technical men, it has been difficult for the politician to use it as a toy. This element of strength may also have involved an element of weakness insofar as logical growth is concerned. It is unnecessary to say that the politician has been more successful in other branches of public service where surveying has been prominent.

The engineer is anxious to erect his professional monuments so that his successors may have cause to praise him and to support his integrity and his skill. There seems to be no good reason why general public surveys should be conducted by more than one department of the government. The Coast and Geodetic Survey has an enviable record. It has already erected much of the framework upon which all other surveys may be supported.

It would be interesting to engineers, and possibly to law-makers and administrative officers at Washington, to have an expression of opinion from those who are concerned only insofar as they desire this work to be performed in the best possible manner. If good reasons can be given for distributing the work through many departments, regardless of the qualifications of the officers having general supervision, heedless of the cost entailed by the duplication of staffs and equipment and without much consideration of uniformity in methods and limits of error, then, like the lion and the lamb, science and politics must lie down together, awaiting the time when public sentiment, shaped by a more general understanding of conditions, will demand a change.

CLARENCE T. JOHNSTON.
Ann Arbor, Mich.

[The Engineering Record will be glad to publish letters from its readers on this subject. There is much to be said on both sides.—EDITOR.]

Courtesy Is Appreciated

SIR: I wish to call the attention of your readers to the exceptional manner in which the contract letting for the construction of Vermillion County Bond Roads was handled at Danville, Ill., March 14, 15 and 16.

In conversation with the many material men, equipment salesmen and contractors, both successful and unsuccessful at the time of the letting, we found without exception unbounded enthusiasm and outspoken praise for the courtesy shown, the facilities offered and the accommodations for work given by the commissioners and their superintending engineer, P. C. McArdle.

There was no question as to detail of construction, choice of material, description of material, grade, in fact, any engineering information at all that was not furnished at once and fully by the superintending engineer's office. Plans profiles, cross-sections, quantities of work—every item that could possibly come up for investigation—had been thoroughly investigated and the most trivial things were given the same careful attention as the most important.

We feel that in so unusual a matter as the contracting for the construction of the Vermillion County Bond Roads in Illinois, the successful handling to the greater satisfaction of all parties concerned, is a thing to be greatly commended, and in making this statement, we give the opinion, not merely of ourselves, but also the opinion of other contractors who bid on the work, successfully and unsuccessfully, as often expressed to us.

A. W. EISENMAYER, JR.,
Vice President, Granite City Lime & Cement Company, Danville, Ill.

HINTS FOR THE CONTRACTOR

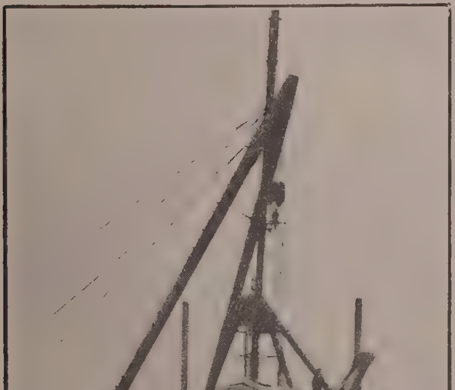
Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

A-Frame on Scows Rescues Steam Shovel from Canal

A heavy A-frame on the head end of two dump scows tied together was recently used in lifting a 35-ton Thew shovel from a flooded portion of the bank-widening work on the Louisville & Portland Canal. The frame was made of 14 x 14-in. timbers with an 18 x 18-in. spud timber base. It was braced securely to the hoppers and tied to the head log of the scows to prevent kicking out. The top was held by four guys, one to each corner. The fall line runs through the outer end boom sheave on the derrick boat, thus taking part of the load off the A-frame. The fall line was of ¾-in. cable with a block of six sheaves, making twelve parts of line in all. The rigging on the scows was counterbalanced by loads in the two rear hoppers and by a dredge dipper and dipper stick that were on the scows for repairs. A government diver hooked the cable slings around the shovel axles at each wheel so that it was picked up nearly level. A barge was run underneath and the shovel placed on it. The four boats were then moved across the canal and the shovel set on the canal wall. The entire job took about four days.



BARGE CARRIES SHOVEL TO BANK

The scows used were each 70 x 20 x 7½ ft., and, when loaded with the shovel, the front ends were 2.8 ft. out of water and the rear ends 5.4 ft. out. The shovel was picked up without an accident of any kind. The contractors in charge have rated the capacity of the outfit at 50 tons.

The outfit was rented from the Western Rivers Company, the sub-contractor taking out the old wall as noted in the Engineering Record on page 794 of the June 26, 1915, issue. Mr. Eppling is their superintendent. The work was carried out for the Henry Bickel Company, general contractors, under the direction of A. G. Butler, superintendent and engineer in charge.

Camp Buildings on Big Road Job Moved Without Being Knocked Down

At one time during the summer of 1914 more than 1000 laborers were employed on the Toronto to Hamilton highway, described on page 520 of this issue. Most of them were fed and housed by the highway commission. The location of camps was changed as the work progressed. Some of the camp buildings were moved without being knocked down, as shown in the accompanying photograph. In one instance the cookery was loaded on skids and hauled to the new location by a gasoline tractor without even taking down the range, the cook preparing a meal en route.

HOW CAMP BUILDINGS ON TORONTO-HAMILTON HIGHWAY WERE MOVED

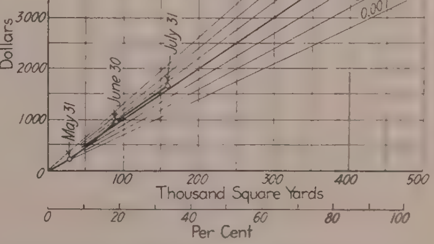
Motion Pictures Hold Lumberjacks in Northern Woods

Motion pictures, shown with a nightly change of program, have enabled the Guerney Lumber Company in Wisconsin to hold steady crews at their camps near Ashland, where formerly the end of a month seldom found more than a man or two at work who had started the month. The lumberjacks would go to the cities, "blow in" their roll and then seek employment at another camp. The motion picture idea was suggested, according to the National Lumber Manufacturers Association, by one of the office employees of the concern. There had been so much trouble in holding men that the company secured an outfit and an operator and gave the plan an immediate trial. A small admission price is charged, which the men are more than glad to pay, and the little show hall is crowded every night and Sunday afternoon with lumberjacks who do not go to town and fail to return next day. The idea has been so successful that several other companies expect to try it in the near future.

Charts Show Monthly Progress and Expenditure on Road Work

By H. S. VAN SCOYOC
Chief Engineer, Toronto-Hamilton Highway Commission

A graphic method of comparing preliminary estimotes with actual monthly results has been found of value in day labor work on the Toronto-Hamilton concrete highway construction. It should be of equal interest to contractors. The vertical divisions on the accompanying diagram represent quantities, the horizontal ones costs. The heavy diagonal line is the estimated unit cost, and the other diagonal lines correspond to unit costs slightly higher and lower than the one used. They serve as the scale by which the monthly results can be interpreted. The scale at the bottom shows the total estimated quantity as well as the percentage completed at the end of each month. Where a def-



MONTHLY PROGRESS AND EXPENDITURE CHART

inite rate of progress has been anticipated this information should be added. The particular sheet shown is for rolling, but similar sheets are used for each item appearing in the preliminary estimate.

Pipe Wrench Can Be Made from a Chain and Crowbar

By JOHN G. BAILHACLY
San Francisco, Cal.

A HANDY pipe wrench can be made in an emergency on jobs where such a tool is not readily available from a chain and a crowbar. It can be used to advantage on pipes ranging in size from 6 to 8 in.

The bar is set up at an angle, through a knot in the chain, on top of the pipe. The chain is then passed under the pipe, around the lower end of the bar and back under the pipe, then wrapped twice around the pipe. The free end of the chain is held and the bar is pulled in the direction it is desired to turn the pipe. This tightens it to a fast grip and the pipe will turn with bar. When the bar is pulled back about 60 deg. it is moved forward for another turn, at the same time pulling hard on free end of chain and sliding it back to the original position without allowing enough slack in it to allow the loop around the bottom of bar to slip off. If the chain is of too large a diameter, there may be a tendency to slip, but this may always be overcome by taking additional wraps around the pipe.

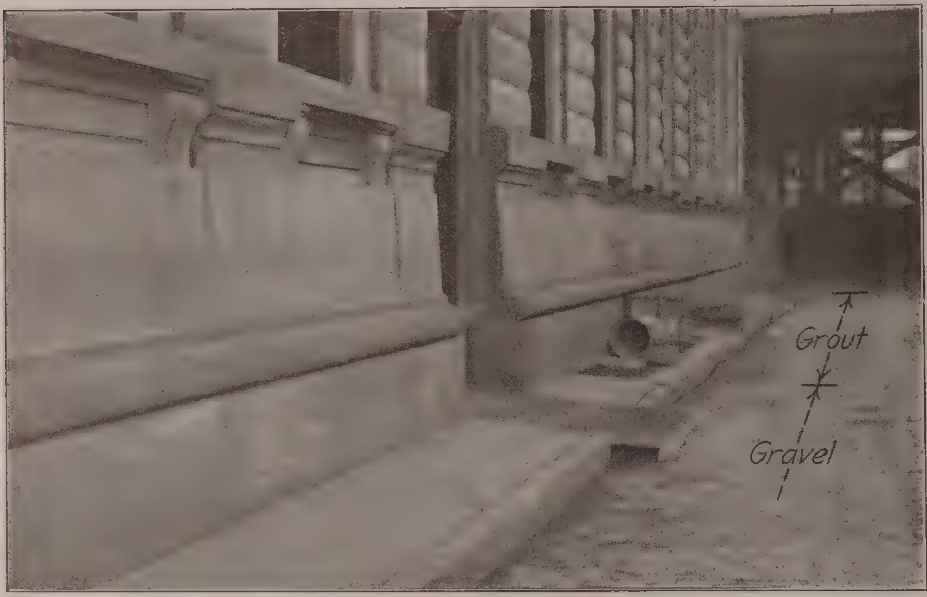
One man can handle the wrench, but it is better to have two. The resistance against slipping is so great that there is very little pull on the end of the chain that is held in the hand.

Gravel Proves Superior to Grout on New York Tunnel Work

GRAVEL, forced outside the cast-iron lining of the various subway tunnels being driven by the shield method in New York City on the work of the Flinn-O'Rourke Company, Inc., has prevented visible settlement of the street surfaces and light structures under which the tunnels have been carried. The gravel is blown through the grout holes in the lining rings by the use of compressed air, in a manner similar to that in which a sand blast is obtained in the ordinary operation of cleaning the fronts of stone buildings.

The gravel used is of two sizes, bird sand and grits, the latter being the larger, and averages about $\frac{1}{8}$ in. in diameter, the bird sand being of about one-half that size. The mixture is both dense and compact.

In the shield driven tunnels that have been built heretofore grout was used for the purpose of filling the space outside the tunnel lining, which is 6 in. smaller in diameter than the shield. The operation usually takes place 50 ft. or more behind the tail of the shield, in consequence of the readiness with which the grout would otherwise flow over the cast-iron lining into the shield. The gravel, being a solid substance, can be blown into the grout holes immediately in the rear of the shield so that as fast as the shield moves forward the space all around the cast-iron lining can be filled with the gravel before the overlying ground has had time to settle into the space vacated by the shield. In the nature of things the grout has never been satisfactory because of the settlement taking place in advance of the grouting and the fact that, as grout requires several hours to harden, the material can settle into it.



SETTLEMENT OF STREET OVER TUNNEL STOPPED WHEN GRAVEL WAS USED

The experience in former tunnels in New York and Brooklyn with the use of grout indicates that under pressure it escapes in all directions through the sand and does not fill the voids left by the tail of the shield. The gravel cannot get away in this manner and seems to completely fill all voids. The accompanying photograph shows plainly the settlement of the street and curb over a grouted section of tunnel and the perfect grade of the street and curb over a section where the gravel was used. The break in the curb corresponds to the ring through which the first gravel was shot. The photographs were taken in Old Slip, Manhattan.

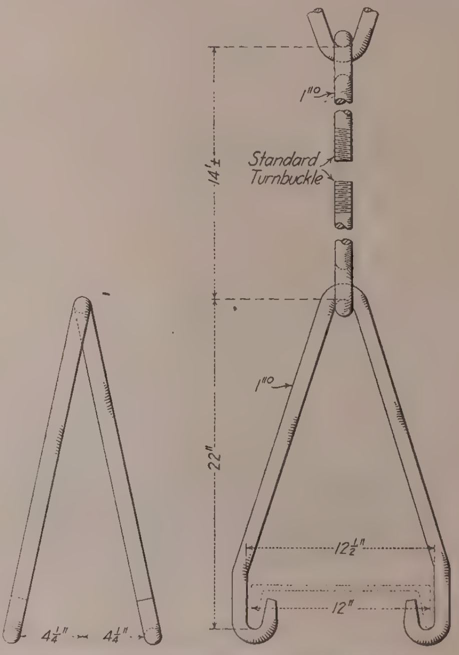
As the contracts with the Public Service Commission were drawn before this method was originated and provided definitely for grouting outside the lining, this is done also, the grout machines following a short distance behind the gravel injector. But for this clause it is thought that grout would hardly be required in addition to the gravel.

In addition to the use of gravel around the tunnel in Old Slip, the same method has been employed in Brooklyn over the Interborough tunnels on Clark Street, and over the New York Municipal Railway tunnels in Montague and Willoughby Streets, with the same success in preventing settlement of the streets or buildings. When the trouble experienced in driving the Interborough Railway Company's tunnels up Joralemon Street is remembered, the importance of the new method is evident. At that time Joralemon Street was completely wrecked and many of the buildings had to be rebuilt.
use are being driven by the Flinn-O'Rourke Company, Inc., of which George H. Flinn is president, and Major John F. O'Rourke, vice-president and general manager, for the Public Service Commission, of which Alfred Craven is chief engineer and Robert Ridgway engineer of subway construction. Michael L. Quinn is general superintendent for the contractor.

Fishhook Ties for Sheet Pile Trench

THE fishhooks, so-called, shown in the accompanying sketch, are made so that they could be easily placed by divers on the master piles of the steel sheet pile trench described on page 513 of this issue. They are slipped over the channel face of the pile and then turned till they engage the channel flanges. After a pair of them are connected with a turnbuckle and tightened they cannot come off.

This trench, in which is being made the shore connection of the Staten Island end of the Narrows siphon under New York Bay, has a flared mouth which collects waves in an onshore wind. Under some conditions these waves have piled up until there was a head of several feet on the inside of the trench. Rather than trust to the cross struts, which could only act in tension through the bolts in their ends holding them to the seat angles, these ties were used.



FISHHOOK TIES FOR SHEET PILE TRENCH

The work is being done under the direction of Ralph E. Chapman of the Merritt & Chapman Derrick & Wrecking Company, the contractors, with Captain Tooker in charge.

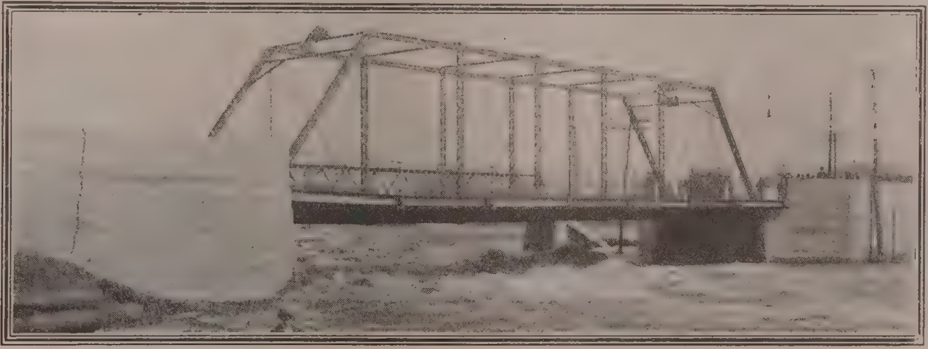
NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

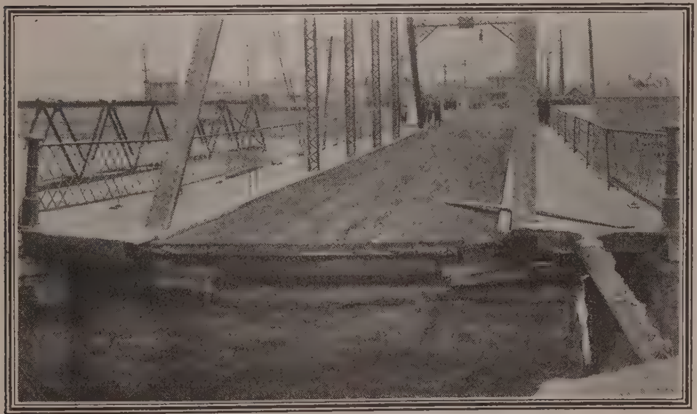
Scouring Out of Abutment Foundation Causes Bridge Failure

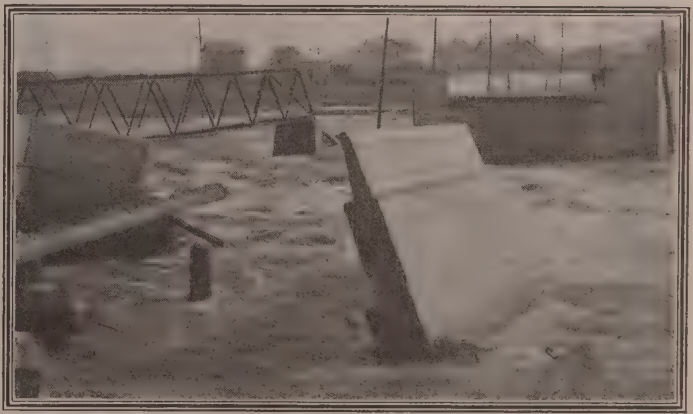
Bridge Abutment at Alpena, Mich., Built on Blue Clay and Gravel with No Piling Is Destroyed by Thunder River Floods

The concrete abutment of a bridge over Thunder River at Alpena, Mich., which had withstood the floods of 27 years, was almost completely destroyed April 2, when an unprecedented discharge of 10,000 sec-ft. was reached. Investigation has shown that the foundation for the abutment was carried down only 2½ ft. below low water mark and was built on a mixture of gravel and blue clay with no piling.



THE FIRST INDICATION OF FAILURE WAS THE CRACK IN THE CONCRETE RETAINING WALLS WHICH IS PLAINLY SHOWN IN THE UPPER PICTURE. THIS HAPPENED SATURDAY, APRIL 1





ON APRIL 2 THE BRIDGE SETTLED 2 FEET, AS SHOWN IN THE LOWER LEFT PICTURE, AND THE COMPLETE FAILURE THAT NIGHT IS SHOWN IN THE LOWER RIGHT ILLUSTRATION

The first indication of failure occurred Saturday, April 1, in the shape of a slight settlement of the abutment and a crack in the concrete retaining walls along the approach, as shown in the top picture. The next morning, April 2, the water washed out the earth filling and the end of the bridge settled about 2 ft., as shown in the picture to the left. About 6.30 p. m., April 2, the abutment and bridge suddenly toppled into the river and by the next morning the approach walls had collapsed.

According to H. G. Roby, hydraulic engineer, of Alpena, Mich., the foundations were not carried down to a depth sufficiently great to give a firm footing, and the scouring section of the river became great enough to overcome the narrow margin of safety with which the abutments were constructed.

During the 27 years the bridge had been in service, floods up to 7000 sec.-ft. had no effect on the abutments. The head on a dam about 400 ft. upstream from the bridge was raised to a maximum of 16 ft. and seven 14-ft. wide tainter gates were open at the time the abutment started to fail. The velocity of the water, as it passed the bridge, was about 12 ft. per second and the direction of the current was diagonally against the abutment which failed. Mr. Roby supplied the information and the pictures of this dam.

St. Louis Engineers Question American Society's Removal

At a meeting of the St. Louis Association of members of the American Society of Civil Engineers held April 3, a resolution was adopted which stated that the communication from the board of direction of the society set forth, in adequate terms, the advantages of accepting the invitation to remove the society's headquarters to the Engineering Building, but did not include objections thereto.

In the opinion of many of the St. Louis members, the objections to the removal, if they exist, should have received as much publicity as was given the advantages.

The St. Louis members commended Col. J. A. Ockerson for giving expression to some of the objections to the removal and voted their appreciation of the work he has done for the society.

Pasadena, Cal., Plans Sewage Disposal Plant to Cost $319,172

After nearly a year's time spent in studying the sewage disposal problems of Pasadena, South Pasadena and Alhambra, Cal., the board of engineers of the three cities has recommended the installation of a plant the estimated cost of which is $319,172. Pasadena's share of the expense is put at $212,247, South Pasadena's at $53,430, and Alhambra's at $53,495. The operating expenses will be approximately $5,400 a year, which allows for a chemist and three attendants.

The engineers investigated the possibility of turning the sewage into the ocean, but this was not feasible on account of the high cost of building so long a sewer and the necessity for treatment before the effluent could be turned into the sea.

New York May Save Over $1,000,000 on City Repairs

Combining New York City's 71 Repair Shops Will Eliminate Present Costly Duplication of Equipment and Labor

By consolidating the seventy-one repair shops now being operated by New York City and giving the head of the new department jurisdiction and control over the management and maintenance of the Brooklyn bridge, operation of the railroad on the bridge, collection of fares and tolls, and construction repair, maintenance, and management of all other bridges in the city, John R. Keefe, chief of the bureau of repairs, estimates a saving of over $1,000,000 a year can be made. The bill to effect this reorganization of the present bridge department under the title of department of plant and structures was recently presented to the Senate, at Albany, and its passage will mean the elimination of much of the present duplication in machinery, buildings and labor. Robert Adamson, fire commissioner of New York City, is said to have made the report to Mayor Mitchell which resulted in the action now being taken.

The bill also provides that the board of estimate may transfer all of the work in connection with the construction maintenance, upkeep, and repair of buildings and structures, the repair of boats, vehicles, apparatus and equipment, to the department of plant and structures.

A possible location for the proposed new building is at the eastern end of the Queensborough bridge. The cost of the building and site would be approximately $1,500,000, much of which could be offset by selling some of the present buildings and grounds.

Under the system now employed, 71 repair shops, superintended by 14 different commissioners, are in operation in different parts of the city at an annual cost of $4,022,394. Many of these shops do the same kind of repair work and few of them are said to be suitably housed or equipped. Each shop having its own machinery, employees and trucks, there is, necessarily, much duplication in equipment and labor as well as a waste of space.

The system under consideration will mean one central repair shop whose annual operating expense will be $2,987,868—just $1,034,526 less than the present cost. Only one set of mechanics and their machinery will be required to handle each class of work; the new machinery will be better protected in a suitable structure; trucks will travel definite routes which will not overlap, and a central stock room will eliminate carrying of supplies at several points. The number of employees necessary under the proposed plan is estimated to be 2500, which is approximately 25 per cent of the number now employed.

New York's West Side Improvement Plans Now on Exhibition

A set of forty-four plans covering the general features of so-called West Side improvement of the New York Central Railroad in New York City has been completed, based on the tentative agreement between the city and railroad reached in January. Copies of the plans are now on exhibition at Grand Central Terminal and at the office of the Board of Estimate and Apportionment. The board will hold a public hearing on the matter April 25. The present tentative agreement was reached by the board's committee on port and terminals, and acceptance by the board itself is necessary before construction work can be started.

As stated in the Engineering Record of Jan. 22, page 126, the salient features of the plan include an elevated structure on private right-of-way east of West Street from St. John's Park to Thirtieth Street; an elevated structure in Twelfth Avenue and the marginal way from Thirtieth to Fifty-ninth Street; covered tracks under Riverside Park and from 135th to 153d Street; covered tracks through the present cut in Fort Washington Park; a viaduct over Dyckman Street, and a cut-and-cover tunnel under Inwood hill. Four yards and terminals are to be provided: A downtown terminal at the south end along West Street to replace that at St. John's Park; a larger one at Thirtieth Street, with tracks on two levels; a main yard and water terminal on the site of the present yard at Sixtieth Street, but with the trackage entirely rearranged, and an uptown terminal, to be used largely for milk, above Manhattan Street. A new high-level drawbridge at Spuyten Duyvil will be required, and above that point the passenger tracks will be spread and the freight tracks carried over and down between them to avoid junction crossings.

Line to Be Electrified

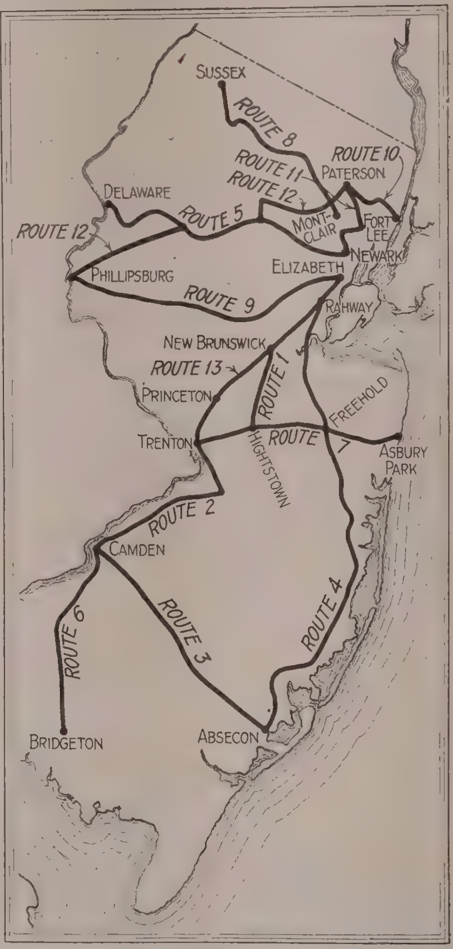
The entire line is to be electrified, the change from steam to electricity being made at Harmon, where the change is now made on passenger trains. The electrification is to be completed in four years from the signing of the agreement, and the whole improvement is to be completed in six years. The estimated cost is given at $50,000,000, but this figure covers the necessary features only. It is understood that additional features desirable to make reasonable provision for the future will make the cost much higher.

The plans have been developed under the joint direction of engineers for the city and the railroad. The city is represented by Ernest P. Goodrich, consulting engineer to the borough president of Manhattan; C. W. Staniford, chief engineer of the Department of Docks and Ferries, and John F. Sullivan, engineer of the Bureau of Contract Supervision of the Board of Estimate. G. A. Harwood, chief engineer of electric zone improvements, and H. D. Jouett, designing engineer of West Side improvements, represent the railroad.

New Jersey Highway System to Cost $7,000,000

With the adoption of the Egan good roads bill by the New Jersey Legislature and its formal approval by the governor, this measure providing for the construction of a state highway system at a cost of $7,000,000 will become effective next fall, and will then be submitted, by referendum, at the general election in November for final ratification.

This act, known as Senate Bill No. 126 and introduced by Senator Egan, of Hudson county, authorizes the construction of thirteen trunk highways throughout the state, including a total distance of about 350 miles and connecting many of the important municipalities. The fund of $7,000,000 to be provided for the construction, an average expenditure of about $20,000 per mile, is to be raised by bond issue and taken care of annually by a portion of the revenue received by the state motor vehicle registration department.



SHOWING THE LOCATION OF NEW JERSEY'S $7,000,000 HIGHWAYS

The new state highway bond issue will comprise either registered or coupon bonds, bearing interest at the rate of 4 per cent a year, payable semi-annually, and in denominations of not more than $1,000 nor less than $100. The payments will be arranged so that the first $500,000, par value, of the bonds shall be payable one year from date of issue, the second amount two years from date, and so on until all are paid. The state motor license fund aggregates about $1,300,000 a year, of which about $720,000 will be required annually to defray the principal and interest of the proposed bond issue.

The bill provides for the establishment of a highway commission, to be composed of the governor, president of the Senate, speaker of the House, state road commissioner, and the chairmen of the Senate and House highways committees of the last Legislature. This commission is to plan and arrange for the construction of the thirteen trunk routes indicated on the diagram map shown in the illustration.

Oregon Takes Steps Toward National Preparedness

The advantage of utilization of the water power resources of the State of Oregon, for the manufacture of nitrates to be used in making munitions in time of war and in the production of fertilizers in time of peace, are thoroughly discussed in *Bulletin* 5, recently issued from the office of the state engineer of Oregon.

The indirect benefits to navigation, irrigation and commerce are pointed out and tentative plans and cost estimates are also included in the bulletin. The authors, who have even gone so far as to discuss the possibilities of marketing the power from the proposed plants, are: John H. Lewis, state engineer; L. F. Harza and G. Stubblefield, consulting engineers, of Portland, and Elmer J. McCaustland, dean of the school of engineering and director of the engineering experiment station at the University of Missouri.

Committee Named for American Waterworks Convention

Arrangements are already under way for making the thirty-sixth annual convention of the American Waterworks Association, to be held in New York City June 5 to 9, the most complete in the organization's history. The committee appointed to develop plans for this year's meeting consists of D. W. French, chairman, superintendent of the Hackensack Water Company, Weehawken, N. J.; Charles R. Bettes, superintendent, Queens County Water Company, Far Rockaway; William W. Brush, deputy chief engineer, Department of Water Supply, New York; Alfred D. Flinn, deputy chief engineer, Board of Water Supply, New York; John D. Kilpatrick, consulting engineer, New York. The entertainment committee of the Waterworks Manufacturers Association includes William C. Sherwood, D. S. O'Brien, J. H. Caldwell, R. E. Milligan, E. T. Pardee and F. S. Bates.

Facilities for exhibits and meetings, which are to be held at the Hotel Astor, are said to be unsurpassed. The exhibits will be staged in the main ballroom of the Astor and there will be individual rooms for meetings of committees.

A feature of the convention will be the presentation of a cup to the section reporting the largest increase in membership per capita. Replies received by President Nicholas S. Hill, Jr., from the various sections and from committees on increase in membership indicate that there will be a lively competition for this trophy.

$40,000,000 River and Harbor Bill Passed by House

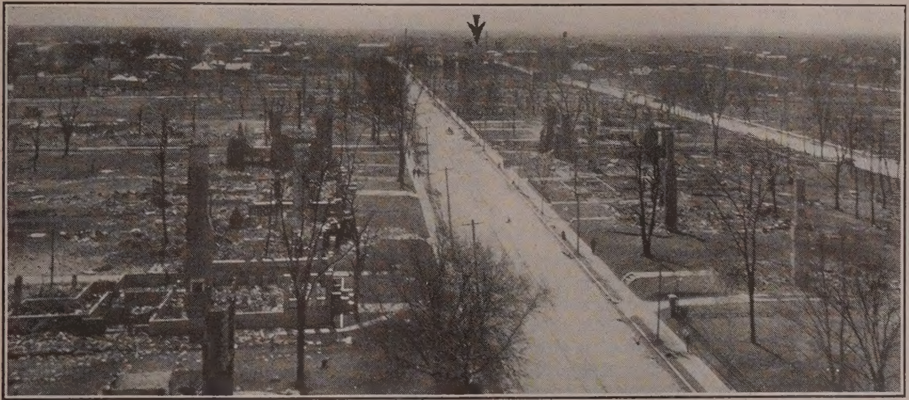
The annual River and Harbor appropriation bill, carrying $40,000,000, passed the House of Representatives April 11, by a vote of 210 to 133. With the exception of $700,000 to be spent in deepening the approaches to the Brooklyn Navy Yards, the entire amount is for continuing the work on improvement projects already authorized. The bill now goes to the Senate for a final vote.

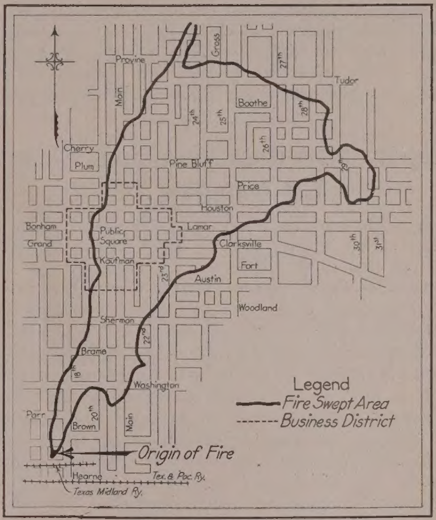
New York Engineers Will March for Preparedness

Plans have been made for a large delegation of engineers to participate in the parade in favor of military preparedness, which will be held in New York City, Saturday afternoon, May 13. Mayor Mitchell, Major-General Leonard Wood and Admiral N. R. Usher will review divisions representing forty professions and trades. The parade will be entirely nonpartisan and no uniforms, horses, wheeled vehicles or advertising will be permitted. The object is to demonstrate the extent of the sentiment of the business and professional men of New York in favor of preparedness.

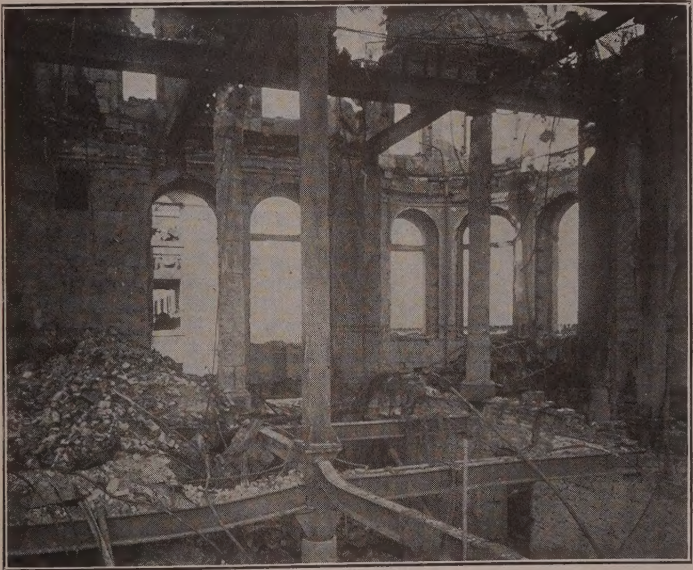
The engineers will form a division, subdivided into the four general branches—civil, mechanical, mining and electrical engineering. Engineers are invited to parade whether they are members of any technical organization or not.

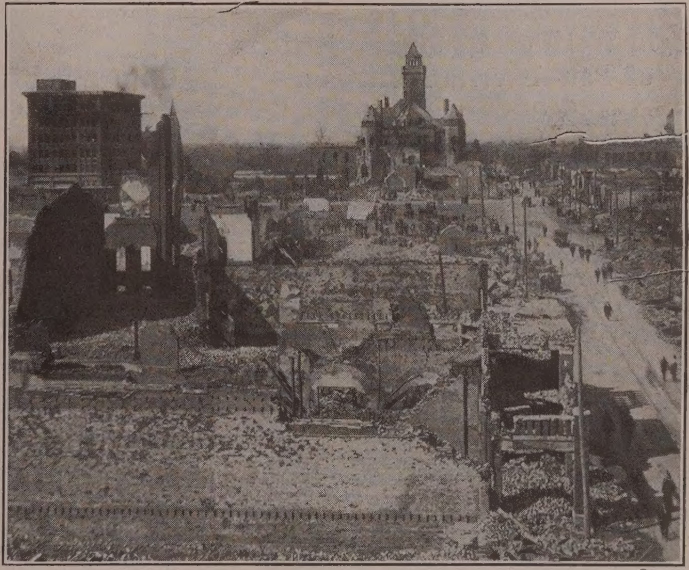
The committee which had charge of the New York military lectures, of which J. S. Langthorn, 250 West Fifty-fourth Street, New York City, is secretary, has undertaken the general organization of the engineering division for the parade and has appointed sub-committees in charge of chairmen as follows: Civil engineers, Charles Warren Hunt; mining engineers, Bradley Stoughton; mechanical engineers, Calvin W. Rice; electrical engineers, F. L. Hutchinson.

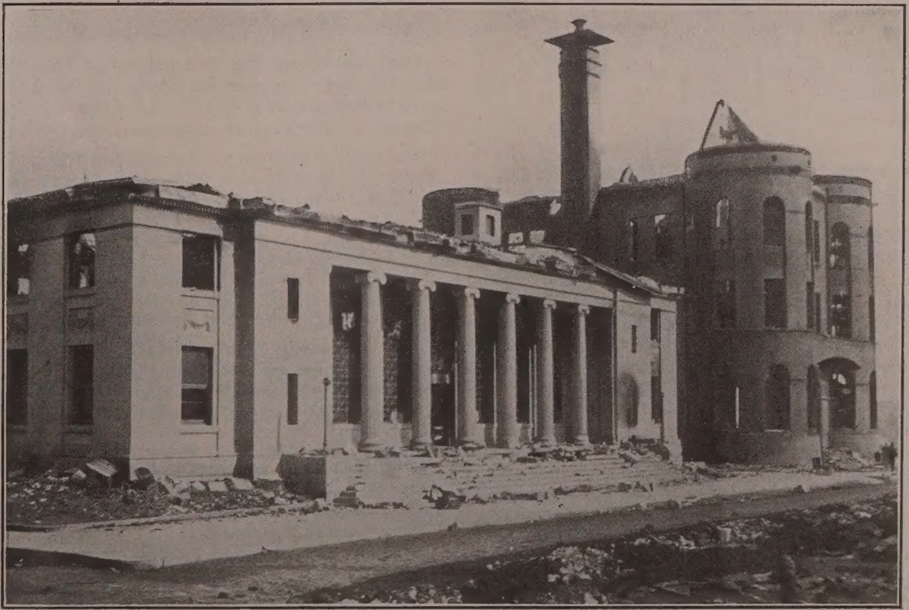




PARIS, TEX., FIRE SPREADS OVER FAN-SHAPED AREA. THE ARROW IN THE UPPER PICTURE INDICATES THE PLACE WHERE THE FIRE STARTED, THE EXACT LOCATION OF WHICH POINT IS SHOWN ON THE MAP TO THE RIGHT. AS IS PLAINLY SEEN, THE FIRE SPREAD OVER A FAN-SHAPED AREA, WHICH INCLUDED NEARLY ALL OF THE BUSINESS SECTION







Views of Fire-Swept Paris, Tex.

1,440 BUILDINGS WERE DESTROYED BY THIS FIRE. THE LEFT CENTER CUT SHOWS THE DAMAGE DONE TO THE INTERIOR OF THE POST OFFICE BUILDING. RIGHT CENTER, GENERAL VIEW OF THE BURNED DISTRICT LOOKING TOWARD FIRST NATIONAL BANK AND COURT HOUSE, WHICH BUILDINGS ARE SEEN IN THE BACKGROUND. THE BOTTOM ILLUSTRATION SHOWS THE POST OFFICE AND FEDERAL BUILDING. THE PARIS FIRE WAS DESCRIBED IN DETAIL ON PAGE 463 OF THE ISSUE OF APRIL 1

Photos by Lang & Mitchell, Architects, Dallas, Tex.

New Haven, Conn., to Have Sewage Disposal Plant

The first move toward securing a sewage disposal plant for New Haven, Conn., entailing an expenditure of nearly $1,000,000, was made when authority was granted last week for the selection of five sanitary experts of that city to act in conjunction with the aldermanic committee on sewers and sanitation.

An investigation will be made this summer, with the assistance of the United States public health service experts. This is said to be the first move the officials of New Haven have made to eliminate the pollution of that harbor.

Report Issued on Municipal Clean-Up Campaigns

A résumé of the various methods and plans adopted by many of the 2500 cities in the United States which took an active interest in "clean-up weeks" during 1914, is contained in the report of data gathered by the bureau of municipal information of the New York State conference of mayors and other city officials, dated March 1. The extensive programs carried out in most of the larger cities show that "the clean-up" movement is not confined to cleaning of streets and vacant lots but extends to the inspection of sanitary conditions in buildings, yards and alleys and even goes so far as to investigate conditions with regard to fire prevention.

Begin Work on Honduran Section of Pan-American Railway

Work on the construction of the Honduran section of the Pan-American Railway, which, it is expected, will eventually link the railways of North America with those of the southern continent, was inaugurated at Simisirán, Honduras, Feb. 26. The line will run from the Salvadoran frontier on the west to the Nicaraguan boundary on the east, and will link the railway systems of the United States, Mexico, Guatamala and Salvador with those of Nicaragua and Costa Rica.

Former Subway Chief Engineer Tells Why He Resigned

In a 48-page pamphlet, just printed, Henry B. Seaman, formerly chief engineer of the New York Public Service Commission, recites the events which led to his resignation from that position in September, 1910. The pamphlet is entitled "An Impossible Engineering Position" and, according to Mr. Seaman's statement in the preface, "describes the condition within the Public Service Commission which led the American Institute of Consulting Engineers to demand that an engineer of reputable standing be appointed upon the Commission."

Unique Dinner to Honor Brig.-Gen. W. M. Black

In recognition of services he rendered New York City as federal engineer of that district and in honor of his recent promotion to the office of chief of engineers, U. S. A., Brig.-Gen. William M. Black was entertained at a dinner given by R. A. C. Smith, dock commissioner of New York City, on April 6. Nearly 100 men were present and a unique idea was carried out by having decorations designed to illustrate some of the work of General Black.

A reproduction of New York's skyline brought to mind the removal of Coenties reef; a picture of a battleship nearing the navy yard suggested the reason for deepening the river channel, and a trans-Atlantic steamer, about to land, brought to mind the 1000-ft. piers.

A few of the prominent guests were: Col. F. V. Abbot, Brig.-Gen. Appleton, August Belmont, Irving T. Bush, Nicholas Murray Butler, Prof. W. H. Burr, S. W. Fairchild, Admiral Harris, Corporation Counsel Hardy, A. Barton Hepburn, William Loeb, Jr., E. H. Outerbridge, Ex-Senator Root, Admiral Usher, U. S. N., Gen. Leonard Wood, and John F. Wallace.

TUNNEL ENGINEERS HAVE UNIQUE MENU

The souvenir menu and song book for the East River (New York) tunnel engineers banquet, which was mentioned in last week's issue, was a well executed and highly interesting piece of work. The attractive front cover, shown above, is representative of the originality that was evident in all of the eight pages.

Nickel Plate Will Make Large Cut by Hydraulic Method

Preparations are being made by the New York, Chicago & St. Louis (Nickel Plate) Railroad in connection with grade-crossing elimination work on the West Side in Cleveland, to excavate 750,000 cu. yd. of material with hydraulic jets, and sluice the material into a near-by gully. This will involve lowering existing tracks. Additional right-of-way has been or will be acquired, and a cut wide enough for two tracks will be made, the present main tracks will be replaced by two in the cut, and then the remaining section will be taken out. Equipment for this work has already been ordered. The work will be carried out under the direction of A. J. Himes, engineer of grade crossing elimination.

News of Engineering Societies

The Alumni of the Massachusetts Institute of Technology among the Pennsylvania Engineers' Society held a dinner under the auspices of that society at Harrisburg on April 7.

The Georgia Drainage Association will meet at Monroe, Ga., May 4 and 5. Many prominent engineers from the South will participate in the work to be done.

The Engineers Club of San Francisco heard Capt. Richard Park, of the United States Board of Army Engineers, give an interesting discussion on military engineering, April 6.

The Engineers Club of St. Louis recently held a meeting at which B. H. Mann, signal engineer of the Missouri Pacific, presented an illustrated paper on railroad day and night signals.

The Harvard Engineering Society of New York will hold a meeting, April 26, at the Harvard Club, New York City. An inspection trip to the West Orange Edison plant will be made that day provided enough members express their desire to attend.

The Engineers Club of Trenton held a dinner April 13, at which Alvin Bugbee, superintendent in the Trenton water department, delivered an illustrated lecture entitled "Preparing Our Water System for Filtered Water."

The Springfield (Ill.) Chapter of the American Association of Engineers was organized with twenty-three members April 3, The officers are: Chairman, A. S. B. Little; vice-chairmen, C. E. Briggs and C. E. Bilger; secretary, T. H. Crandall.

The Engineers Club of Philadelphia will hear Col. Geo. A. Zinn, corps of engineers, U. S. A., discuss "Military Engineering" at a meeting to be held this evening. Colonel Zinn will also speak on this same subject April 29, and conclude the series of four lectures given by him on this subject.

The Southwestern Waterworks Association, representing the states of Kansas, Arkansas, Texas, New Mexico, Louisiana, Missouri and Oklahoma, will hold a convention at the Raleigh Hotel, Waco, Texas, May 8-10. Interesting business and entertainment programs have been arranged, and exhibits will be shown in the basement of the hotel.

The Brooklyn Engineers Club, at a meeting in the society rooms April 13, enjoyed an illustrated lecture on "The Manhattan Bridge Plaza Improvements," by Charles N. Pinco, assistant engineer in the department of bridges, New York City. An informal smoker will be held at the Imperial Hotel, Brooklyn, April 25, tickets for which will cost $1. The proceeds will be devoted to improving the society's headquarters.

The Colorado Association of Members of the American Society of Civil Engineers will be addressed to-night by Andrew Weiss, project manager, United States Reclamation Service, on "The Drainage of Irrigation Projects, with Special Reference to the North Platte Project." The committee on change of headquarters will make a progress report. Charles D. Marx, past president of the society, and Edwin Duryea, Jr., director, will be the guests of the association. L. R. Hinman, secretary, reports a good attendance at the regular Wednesday luncheons.

The American Institute of Electrical Engineers will meet at the New Willard Hotel, Washington, D. C., April 26, under the auspices of the Washington section and the committee on development of water power. The program for the meeting, as at present arranged, includes an address by President John J. Carty, and papers on the following subjects: "Electrochemical Industries and Their Interest in the Development of Water Power," by Lawrence Addicks; "Water Power Development and the Flood Problem," by Allerton S. Cushman; "The Relation of Water Power to Increased Transportation," by L. B. Stillwell; "The Relation of Water Power to the National Defense," by W. R. Whitney, and "The Water Power Situation, Including Its Financial Aspect," by Gano Dunn.

Personal Notes

H. M. CORLISS, who is connected with the F. T. Ley Company, of Springfield, Mass., has been transferred from Hartford, Conn., where he had charge of the concrete work on the Nepaug dam, to Longmeadow, Mass., to take charge of tunnel work to be done for the Southern New England Telephone Company.

LESLIE K. HARLOW has been appointed resident engineer in charge of conduit construction for the Bay State Street Railway Company, with headquarters at Newport, R. I.

M. R. LEWIS has recently been put in charge of an experiment station conducted by the U. S. Department of Agriculture, at Twin Falls, Idaho

VAUGHN WOOD has resigned from his position in the harbor department of Los Angeles to become connected with the Missouri, Kansas & Texas Railroad.

PERCY H. WILSON, who recently resigned from the position of secretary for the American Portland Cement Manufacturers' Association, has opned offices in the Land Title Building, Philadelphia, where he will engage in consulting practice. His work during the eight years he acted as secretary to the association made it the effective organization it now is. Mr. Wilson is a graduate of the civil engineering department of the University of Pennsylvania, and from 1894 until 1907 was connected with the River and Harbor Improvement Company, of Camden, N. J., during which time he rose from the position of superintendent to that of engineer and an executive of the company.

R. H. RANDALL, assistant engineer in charge of topographic surveys at Dayton, Ohio, has gone to Jackson, Mich., where he will take charge of a topographic survey for that city.

H. L. DOUGHERTY was promoted to the position of superintendent of highways in Washington county, Pa., April 11. Mr. Dougherty has been with the state highway department four years and was attached to the office in district No. 10, with headquarters at Wellsboro, at the time of his promotion. He is a graduate of Pennsylvania State College and became connected with the state highway department as rodman in 1912.

GEM STATE WATER COMPANY, of Ogden, Utah, has been organized to complete work begun by the Lost River Water Company on the Big Lost River irrigation project. Construction work will begin immediately at Mackay, Idaho.

A. W. THURSTON, formerly assistant engineer for the Utica Gas & Electric Company, of Utica, N. Y., is now connected with the engineering department of the National Tube Company, at Lorain, Ohio.

W. G. URE has been transferred from King's Mills, Ohio, to the main office of Wells & Gray, Ltd., Toronto, Canada.

JOSEPH P. NEWELL, GEORGE C. MASON and JAY L. STANNARD have been selected by the Oregon chapter of the American Society of Civil Engineers to assist the city council of Portland in the investigation of alleged frauds in connection with the construction of the Montavilla trunk sewer.

ERIC T. KING, for ten years an assistant engineer with the board of water supply of New York City, has resigned to become assistant to Lederle & Provost, sanitary experts and consulting engineers, of New York City. Mr. King studied sanitary engineering at Union College, from which he was graduated in 1905. After graduation, he spent six months with the U. S. Geological Survey on river-control studies in Oklahoma, and five months as water supply engineer with the department of health of New York. Since May, 1905, he has been engaged on the preliminary work and construction of various portions of the Catskill water supply system for New York City, including the siphon tunnel under the Hudson River, steel and cast-iron pipe lines, and Silver Lake reservoir.

L. W. SWETT, until recently associated with Prof. A. N. Talbot of the University of Illinois, has been appointed superintendent of construction for the Brooks Construction Company, of Fort Wayne, Ind. Previous to graduation in 1914, Mr. Swett spent several years on gold dredging work in Siberia.

C. B. HARDING has been appointed structural assistant in the department of public works of Portland, Ore., and assigned to duty on the work being done on the Oregon-Washington Railroad and Navigation Company's line in that city.

ROBERT B. ROBINSON, formerly division engineer for the Oregon Short Line, has been appointed engineer, maintenance-of-way, which position has been created to take care of the maintenance of the increased mileage of that road. Mr. Robinson began engineering work during the summers of 1894 and 1895 in Government service and in 1896 was leveler and transitman for the St. Louis, Peoria & Northern Railroad. He was assistant construction engineer on the Mere Docia levee and drainage commission works in Illinois during 1897, and, in the spring of 1898, took up special civil engineering studies at the University of Illinois. After a few months at that university, he became associated with B. B. Harts, consulting engineer, of Clinton, Iowa, and in 1899 joined the engineering department of the Union Pacific. His promotion comes after service with the Oregon Short Line from 1904 to date.

EDGERTON C. GARVIN, at present connected with the Government engineer's office at Savannah, Ga., has moved to Brunswick, Ga., to become assistant engineer in charge of the harbor works at that city. Mr. Garvin was graduated from the engineering department of George Washington University in 1907, spent the summers from 1900 to 1906 in the employ of the U. S. Geological Survey and has been doing special harbor and river work for the engineering department of the government since 1908.

ARTHUR F. HOLLAND, in the employ of the H. Koppers Company, of Pittsburgh, has been transferred to Jersey City, N. J., to act as field engineer on the construction of a plant to be erected for the Seaboard By-Product Coke Company.

W. S. WICKER has resigned from his position as assistant engineer for the Baltimore Sewerage Commission to become a member of the field engineering force of Chester & Fleming, consulting engineers, of Pittsburgh, with headquarters at East Liverpool, Ohio.

J. D. ANKROM has left the employ of the war department, where he held the position of inspector and engineer for the Wheeling district, to accept a position as assistant field engineer for H. Koppers Company, with headquarters at Jersey City, N. J.

E. NEWMAN will again assume his position as assistant engineer and superintendent of construction for the San Joaquin Light & Power Corporation's plant at North Fork, Cal. Work on that plant was suspended last November and Mr. Newman expects to complete the job this season.

RUDOLPH P. MILLER, who did important work as expert for the building committee of the board of aldermen of New York City in its revision of the building code, has been retained by that committee to assist in revising the part of the code dealing with theaters.

JOHN P. SHEA, formerly with the Aberthaw Construction Company, has become associated with Stone & Webster Construction Company as general foreman on work being done for the Blackstone Valley Gas & Electric Company, at Pawtucket, R. I.

WARREN A. HOYT has discontinued his consulting engineering practice in Chicago, to engage in the building business in central Pennsylvania, with headquarters at Altoona. He will specialize in reinforced-concrete construction.

E. H. MCGOVERN has been made resident engineer of the Cleveland, Cincinnati, Chicago & St. Louis Railway, with headquarters at Columbus, Ohio.

C. L. DOUTHETT, division engineer of Vermilion County (Ill.) bond roads, has moved from Danville to Sidell to take charge of 20 miles of concrete road construction.

A. G. HILLBERG, hydraulic engineer, of New York City, has been retained to investigate and report upon a proposed hydroelectric development on the Gila River, above Red Rock, N. M. Mr. Hillberg recently completed the designs for a 25,000-hp. hydroelectric development located at the mouth of the White Rock Canyon of the Rio Grande River.

WIHTRED COOK, who has been associated with H. E. Riggs, of Ann Arbor, Mich., is now a member of the engineering staff of the Rochester Railway & Light Company, with headquarters at Rochester, N. Y.

F. H. SHERRERD has resigned from his position in the city engineering department of Newark, N. J., to take effect May 1.

L. R. COLEMAN has left the employ of the engineering department of the Delaware, Lackawanna & Western to enter the engineering department of the Pennsylvania Railroad, with headquarters at Trenton, N. J.

M. M. O'SHAUGHNESSY, city engineer of San Francisco, has been permitted to accept the position of consulting hydraulic engineer for San Diego. His work for San Diego will consist of the reconstruction of several dams.

GEORGE W. FULLER, consulting engineer, of New York City, has been retained to advise on the question of the most suitable sewage disposal project for that city.

M. D. ANDERSON is temporarily in charge of the Arizona district of the U. S. Geological Survey, succeeding C. C. Jacob, whose transfer was noted in the April 1 issue.

HENRY HARVIE has resigned from his position as designing engineer for the Rochester Railroad & Light Company to become chief draftsman for the hydraulic department of the Hydroelectric Power Commission of Ontario, with headquarters at Toronto.

W. K. HATT, professor of civil engineering at Purdue University, gave a course of lectures upon the fundamentals of reinforced-concrete construction during the past week at the University of Ohio.

W. F. LANGELIER, assistant to Prof. Edward Bartow, director of the Illinois State Water Survey, has accepted a position as assistant professor of sanitary engineering at the University of California. Mr. Langelier has had charge of the tuning up of several Middle West filtration plants, among which are those at Evansville, Ind., and Quincy, Ill.

L. SPALDING has been appointed acting supervisor of structures of the Bessemer & Lake Erie Railroad. Mr. Spalding was graduated from Cornell University in 1913 and subsequently spent a few months with the Pittsburgh, Shawmut & Northern. He went to the Bessemer & Lake Erie about two years ago.

Obituary Notes

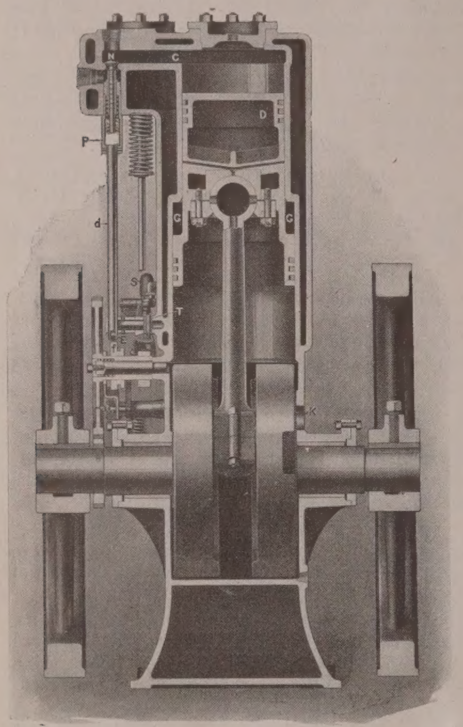
SIR COLIN CAMPBELL SCOTT-MONCRIEFF, well known as an authority on irrigation, died in London, England, April 6, at the age of 80. He was the creator of the present system of irrigation in British India, where the canals aggregate, in extent, the circumference of the globe, and he also inaugurated a similar system in Egypt. Since these works, which took almost half a century to complete, he has been consulted in irrigation projects by the Turkish, German, and Russian governments, and was largely responsible for the idea carried out by Russia in the river regulation and canal construction of its transcaspian and central Asian possessions.

COL. H. ASHTON RAMSAY, who was the only living honorary member of the Engineers' Club of Baltimore, died recently in that city.

New Air Compressor Burns Kerosene, Gasoline or Gas

A portable, two-stage, vertical air compressor, the power for which may be obtained by using gasoline, kerosene or gas, has been brought out by the Lyons Atlas Company of Indianapolis. The power and air cylinders are contained in a single casting, which effects an appreciable reduction in weight and number of parts, and makes the device more compact.

When the air piston is at the top of its stroke, the crank case is full of air at atmospheric pressure, admitted through port *K*, shown in the illustration. On the downward stroke, this air is compressed in the crank case after which it flows into the annular chamber *G*, and raises the absolute pressure therein to approximately 20 lb. A valve closes as the piston starts on the upward stroke, and as soon as the pressure in the annular space *G* reaches the receiver pressure, the discharge valve opens, allowing the air to pass into the receiver during the remainder of the upward stroke. Since the pressure in the crank case assists the piston on the upward stroke, and the location of the port in the crank disc is such as not to open port *K* until atmospheric pressure is reached, but little work is lost and high efficiency is said to be secured.



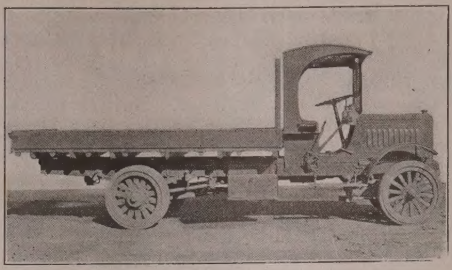
LIGHT WEIGHT AND COMPACTNESS ARE THE ADVANTAGES CLAIMED FOR THIS COMPRESSOR

Light Weight Is Feature of New Worm Drive Motor Truck

Lightness without diminished strength was the principal object sought in the design of the Riker worm-drive motor truck, which, though perfected over a year ago, has only recently been put on the American market to any extent, the output having gone almost exclusively to the warring countries in Europe. The low proportionate weight is attained by the quality of the materials used. The frame, for example, is of chrome nickel-steel instead of pressed steel.

Practically no aluminum is used in the make-up of the Riker truck, the transmission case and the crank case being of manganese bronze. This, in fact, is an exclusive feature of the Riker truck. On the 3-ton model the rear-spring suspension is from 3 in. to 4 in. greater than the spring suspension used on the ordinary 5-ton trucks.

It is believed, by the manufacturer, that the trucks are, for their size, the lightest on the market and that they are the only trucks equipped with five-bearing crank shafts.



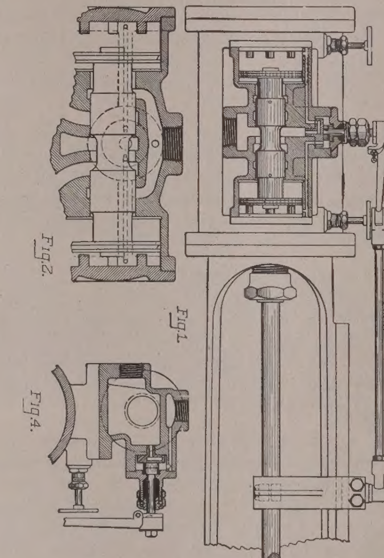
SPRING SUSPENSION GREATER THAN USUAL TRUCK

The type has been tried out under severe conditions in war service. It is manufactured by the Locomobile Company of America, of Bridgeport, Conn.

New Type of Valve Regulates Steam According to Work

A new pump has been put on the market by the American Steam Pump Company of Battle Creek, Mich., which is equipped with a new type of valve gear that, it is claimed, because it is mechanically actuated, insures positive action at all times, and, due to a self-governing device with which it is equipped, will permit only enough steam to enter to do the required work.

The new pump, known as the "American-Marsh," is of simple construction. The steam valve is of the balanced piston type, equipped with expansion rings, while the auxiliary valve is of the semi-rotative disc type which wears to a perfect seat. There are no slide valves to wear and no loose links or tappets in the valve gear.



VALVE GEAR IS SELF-GOVERNING

As will be noted from the accompanying cut, it has a steam valve which is mechanically actuated, and which is also self-governing. The fact that it is mechanically actuated, it is claimed, insures positive action at all times, while the self-governing device allows only just enough steam to enter it to do the required work. If the work is light, the admission of steam is cut down, while if the work is heavy the portage is automatically enlarged. This feature, it is said, insures low steam consumption.

Chicago Concern Moves Office

The Chicago office and sales rooms of the Goulds Manufacturing Company, of Seneca Falls, N. Y., will be removed to 12 South Clinton Street, April 20.

Solid Steel Windows Successfully Withstand Test

A test was recently conducted by the New York State Industrial Commission at the fire-testing station of Columbia University to determine whether solid steel windows would successfully withstand the heat they would be called upon to meet under actual fire conditions.

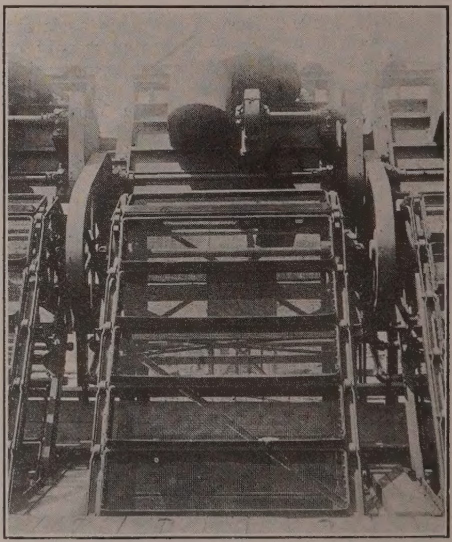
The test was conducted by Professor James S. MacGregor, of Columbia University, with Fenestra solid steel windows. He reported that "after the test, all three vents of the windows used were opened without difficulty and could be swung, closed and locked with ease."

The results of the test are said to remove a handicap to the use of such windows, especially in the State of New York. An old state law practically limited the sale of solid steel windows to units not exceeding 5 ft. wide and 9 ft. high. The demand of manufacturers and building owners, however was thought to be for a steel window that could be used singly or in combined units of practically any size needed. The approval of the industrial commission of this type of window is an added assurance to building owners that they can use solid steel windows for safety against the fire hazard.

Intake Screens Driven by Motors

A few experimental installations of automatically cleaned traveling screens to provide clean water in power plants and to screen sewage have been successful enough to warrant the manufacture of the screens by the Chain Belt Company of Milwaukee. Among the first installations were the Northwest and Fisk Street plants of the Commonwealth Edison Company of Chicago; the Delray plant of the Edison Illuminating Company of Detroit, and the Commerce Street plant of the Milwaukee Electric Railway & Light Company. The battery of three screens, a section of which is shown, was the first installation placed at the Northwest plant.

The machines consist of wire screening baskets mounted on two strands of endless steel chain belt passing over top and bottom sprockets which are mounted on a structural steel supporting frame. Each screen, with its attendant equipment, is driven by its own motor mounted near the top of the frame. Number 12 copper wire is strung to produce 0.625-in. mesh. The baskets, measuring 5¼ x 1½ ft., form a continuous screening apron as they move slowly upward through the water. As they pass over the top sprocket, they dump their loads into a trough and are cleaned by water from a continuous spray pipe.



SHOWING A PART OF THE BATTERY OF THREE TRAVELING SCREENS